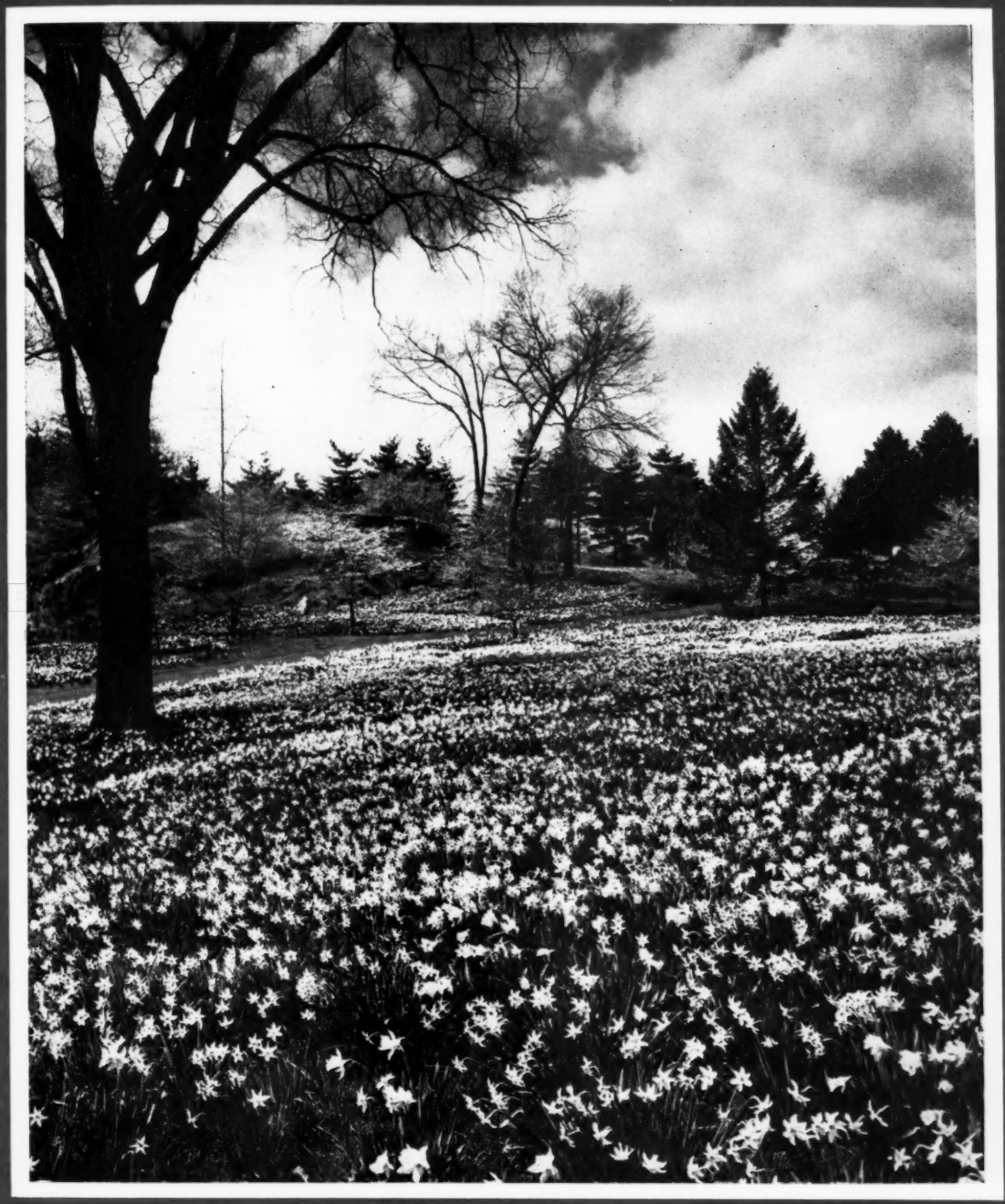

THE GARDEN JOURNAL

THE NEW YORK BOTANICAL GARDEN

Vol. 11, No. 2 March-April, 1961

THE GARDEN JOURNAL

THE NEW YORK BOTANICAL GARDEN

DOROTHY EBEL HANSELL
Editor

In this issue emphasis is placed on various facets of the work of The New York Botanical Garden in articles contributed by the Director and members of the staff.

The eight pages in the center (53-60), "Guide to Trees," are the first installment of a series under this title. They may be removed if the reader desires. The entire series will be reprinted separately.

CALENDAR

April 18-28, 1961. Third International Rock Garden Conference arranged jointly by Alpine Garden Society in London, with cooperation of the Royal Horticultural Society, and Scottish Rock Garden Club in Edinburgh, with cooperation of Regius Keeper, Royal Botanic Garden, Edinburgh.

April 22-29, 1961. Twenty-eighth annual Historic Garden Week in Virginia.

April 26, 27, 1961. Gramercy Park Association Annual Flower Show at the National Arts Club, 15 Gramercy Park, South, New York, N. Y.

April 28-June 15, 1961. Fiorio del Mondo a Torino, Valentino Exhibition Palace and Grounds. For information, write Guiseppi Ratti, Via Pomea, 32, Turin, Italy.

May 2 and 9, 1961. City Garden Clubs—annual showing of gardens and pent-house terraces in New York, N. Y.

May 10, 1961. Spring Garden Tour to Bucks County, Pennsylvania, sponsored by The Volunteer Associates of The New York Botanical Garden. Note change in date from May 4 to May 10.

May 12-14, 1961. International Rhododendron Conference in Portland, Oregon, under the auspices of the American Rhododendron Society.

May 15, 1961. Annual Meeting of The New York Botanical Garden.

May 16, 1961. Torrey Botanical Club meeting at The New York Botanical Garden.

May 17, 1961. Spring Garden Party at The New York Botanical Garden.

May 25-29, 1961. Annual Meeting of the American Iris Society; headquarters, Robert Treat Hotel, Newark, N. J.

May 26, 1961, 2 P.M. American Iris Society visits The New York Botanical Garden and celebrates its founding at the Garden forty-one years ago.

June 13, 1961. Nineteenth Annual Rose Day at The New York Botanical Garden.

October 25-27, 1961. Sixteenth Annual American Horticultural Congress, Northampton, Mass.

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CREDIT FOR ILLUSTRATIONS

We are indebted to the Display Committee, Mrs. Charles Burlingham, Mrs. Richard S. Meredith, Mrs. Donald B. Straus, for the selection of the front cover illustration—a spring scene at The New York Botanical Garden, photo by Gottscho-Schleisner; pp. 37, 38, H. W. Rickett; pp. 42, 43, P. Hale; pp. 44-46, R. M. Klein; pp. 49, 50, 52, E. N. Mitchell; pp. 56-60, T. H. Everett; p. 54, map, and p. 63, **Liriodendron tulipifera**, C. C. Clare, Jr.; pp. 65, 66, D. R. Egolf; p. 67, Gottscho-Schleisner; p. 68, upper, Gottscho-Schleisner, courtesy Jackson and Perkins; p. 68, lower, Old Westbury Gardens; p. 76, J. H. Clarke.

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FLOWERS AND THEIR FRUITS

By HAROLD WILLIAM RICKETT

Dr. Rickett is Acting Assistant Director (Botany) and Bibliographer of The New York Botanical Garden.

Most persons have never seen a flower.

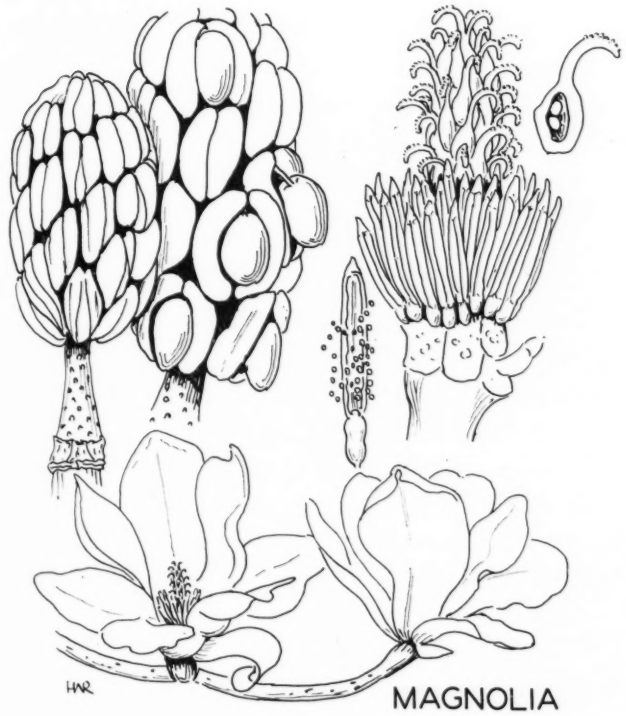
Of course that is an absurd statement. We have seen them in our parks, our gardens, our homes, perhaps in hospitals or churches.

And yet there is truth in it. Most persons have never *seen* a flower. They have seen beautiful colors, graceful forms. They can distinguish a rose from a lily, a peony from a chrysanthemum. But most peonies lack the essential parts of a flower. And a chrysanthemum is not one flower but a mass of many minute flowers—and these also may lack essential parts.

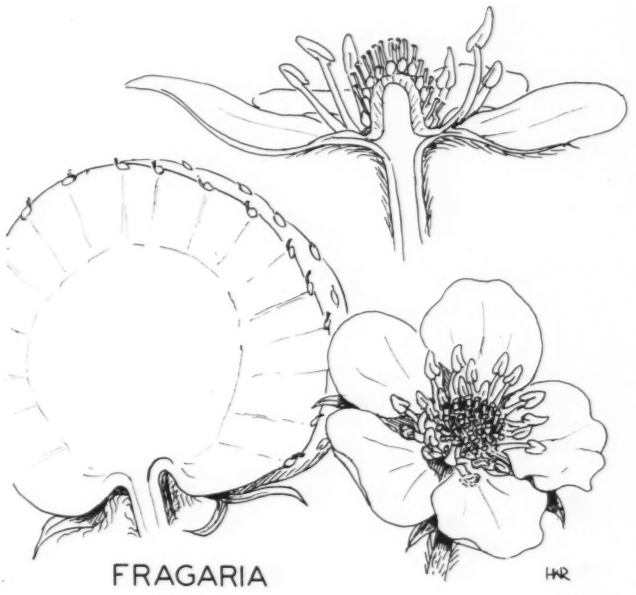
What is essential in a flower? Brightly colored petals are the most obvious parts; the green sepals cover them in the bud. But many flowers lack petals and not a few lack sepals also. The flowers we grow in gardens generally have delightful odors. But there are flowers that smell like a skunk or like putrid flesh. Many flowers—including those of chrysanthemums and dahlias—are small, and their parts must be sought with a magnifier. But some are large and can be investigated with the unaided eye.

A flower of magnolia will do for a beginning. The lovely pink or white petals and sepals (they are all alike) need no introduction. In the center of the chalice rises a sort of tower or pillar, covered with small projections of two kinds. *These are the essential parts.*

At the base of the pillar are a number of short red or golden straps, curving upwards. These are stamens; they form the fertilizing dust, the pollen. Above these, pear-shaped bodies are pressed against the pillar, their narrow necks at first bent in but at full flowering curving outward. These are pistils. In the basal part of each pistil, called the ovary, is a very minute body, an ovule; or in some there may be two. "Ovule" means "little egg," and the ovary is so named for containing these "eggs." The analogy with animal reproduction is false. An ovule is not an egg; it becomes, when fertilized, a seed.



MAGNOLIA

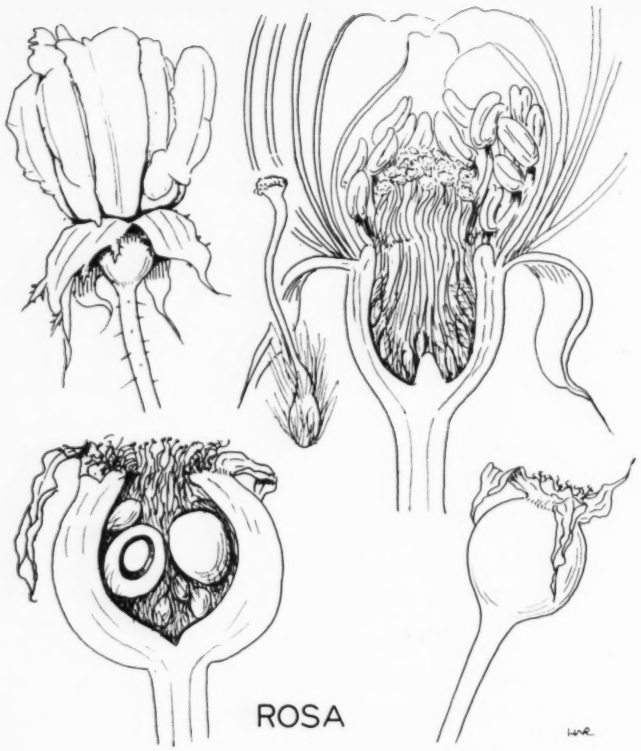


FRAGARIA

Fertilization is accomplished in three steps. First, pollen is transferred—by wind, by gravity, by insects, by other agencies—from the stamen where it is formed to a receptive, more or less sticky area, the stigma, at or near the tip of the pistil. The narrow part between ovary and stigma is the style (so named from the Greek word for "column"). Pollen consists, like the dust for which it is named, of a multitude of microscopic grains. In the second step, each grain, when deposited on a stigma, may grow, putting forth a microscopic living thread, as a seed puts forth a root. This thread penetrates the style, may eventually reach the cavity where the ovule lies, and may then enter the ovule. The third step is an actual union of living cells in the ovule, one cell from the pollen, one from the ovule; and an embryo, a new plant in miniature, is formed. The rest of the ovule forms the protective and nutritive layers around the embryo—and we have a seed.

After fertilization, the magnolia ovary around the new seed (or seeds) enlarges, becomes succulent, takes on a red color. This is what the botanist calls *fruit*. Each single ripened pistil is a fruit. But the botanist is not altogether consistent in his use of the word: he calls the entire mass of ripened pistils also a fruit, an "aggregate" fruit. When they are fully ripe, the fruits split open and the orange seeds project—attached for a time by thin threads.

Once I came on some small colored girls surveying a



large magnolia. They asked me what those red things were. I explained, as best I could. Then they wanted to know what good they were. I suggested that they might fall to the ground and grow new magnolia trees. "Mistuh," said one, round-eyed, "Do yuh mean t'say that those trees *grew?*"

The trees grew—from seeds formed in fruits through the action of pollen. That is the origin of all flowering plants. The essential players in the drama are the pistils and stamens. The beautifully various sepals and petals—collectively called the perianth, the "around-the-flower"—are merely accessory to the plot, dispensed with altogether by many species. The pistils and stamens differ in many ways in different species; but in all they are *essentially* alike and accomplish *essentially* the same result.

The botanical use of the word "fruit" may surprise the reader. Apples certainly are fruits, and peaches, and berries of various kinds. But to extend the word to refer to the inedible products of trees may seem a perversion of English. The point is that the botanist names things according to their origin, not their edibility. Fruits are the bodies that develop from flowers, no matter what their form or flavor.

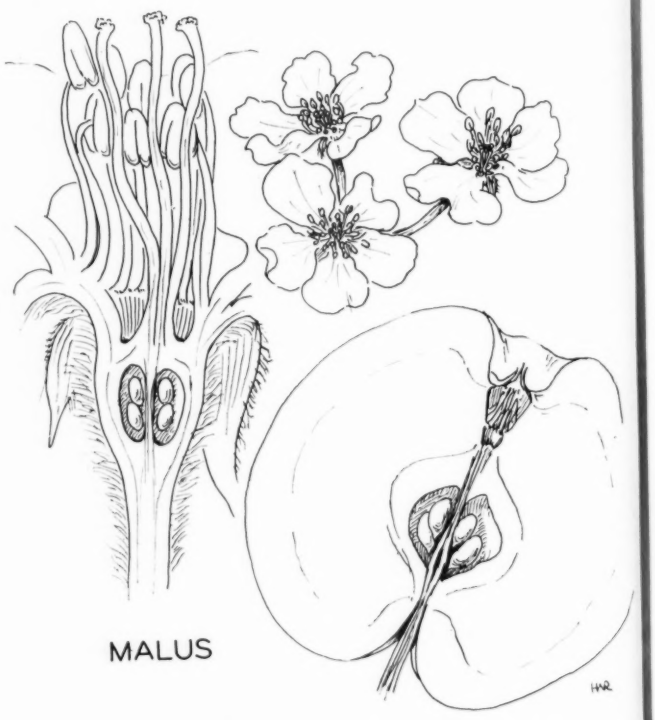
Even our edible fruits are of a surprising variety when one studies their botanical origins; berries, for instance. A strawberry is a succulent, red, delicious fruit, with a stalk and some small leaves at the broader end, and covered with seeds. What? Seeds on the *outside* of a fruit? This must be something different from the fruit described above.

It is. For a proper comparison it is necessary to look at its beginning—in the flower. Few that enjoy a strawberry shortcake have ever turned a magnifier on a flower of *Fragaria.* It has usually five white petals and the same number of sepals, with an extra rank of small leaves called bracts: all forming the perianth. In the center rises a dome or hump, comparable to the central tower of a magnolia but shorter; and covered with minute pistils. (The stamens are out on the perianth, somewhat removed from the central edifice.) Pollination, fertilization may proceed as usual; each small ovary contains a single ovule and becomes a small, one-seeded fruit—the "seed" on the surface of the berry. The edible berry itself is that central dome, tremendously enlarged and changed. Each "seed" is really a fruit, botanically; the entire mass is also a fruit, in the characteristic botanical double talk.

An amusing contrast is furnished by a rose. Any one who frequents gardens must have noticed, just beneath the brilliant petals, a swelling of the stem, a pedestal on which the flower is borne. If the flower is sliced from top to bottom, this enlargement of the stem is revealed as a hollow urn, bearing many woolly pistils on its inner surface and the other parts of the flower on its rim. Again the pistils become small one-seeded nuts (wrongly called seeds by most persons), all surrounded by the enlarged, succulent, red urn: a strawberry turned inside out.

The ways of flowers are of infinite variety. A blackberry or raspberry starts in a flower much like that of a strawberry plant. But each tiny pistil becomes a small succulent globe with a hard center (like a miniature cherry). Inside the hard central stone is a seed. Each segment of the berry is therefore a fruit; the central projection of the flower, on which the pistils stood, does not here become succulent, edible; the pistils do.

It is evident that the word "berry" has no exact significance, in botany or otherwise. A blueberry comes from a flower with only one pistil; if we search among fruits for something comparable we come to grapes and even bananas —shall we call these berries? We can only unite blueberries, strawberries, and raspberries under one term by ignoring botanical facts. If, on the other hand, we attempt to make a purely botanical definition of "berry," we reach the absurd statement suggested above—that bananas are berries but strawberries are not. Indeed the same difficulty is met



in attempting a definition of "fruit." In the above examples we have "fruits" formed of a mass of inedible pistils, of an enlarged floral stem-end, of a group of cherry-like pistils, of an urn formed from the expanded flower-stalk . . .

An apple blossom introduces us to yet another complexity —as well as to an apple. Close examination of the flower reveals the usual sepals and petals (typically five of each); a crowd of stamens; and, in the center, five slender styles with expanded tips which must certainly receive pollen—but where are the corresponding ovaries? A vertical slice through the flower reveals them—apparently in the stem just below the sepals. This corresponds to their place in a rose. But here in the apple the ovaries (generally five) meet in the center and are embedded on all other sides in the substance of the flower-stalk. The association is so close that the ovaries cannot be lifted from the surrounding material; indeed it is impossible, even with a microscope, to determine where ovary ends and flower-stalk begins. Because of this the stamens, petals, and sepals seem to grow from the top of the united ovaries themselves; and these are spoken of as "inferior" (lower). Actually anatomical study shows that the flower parts, joined with each other and with the stem that bears them, extend up around the ovaries.

And from the whole complex mass comes the apple itself. As everyone knows, the stalk of the fruit is at the opposite end from the sepals and remains of the stamens. The enlarged end of the stalk with its contained parts intervenes. A slice across an apple discloses the cavities of the five ovaries—but not just how far out they extend into the edible flesh.

Strawberries, raspberries, huckleberries, apples—these are fruits we know. Rose hips are not common on our tables, but can serve as an ingredient of jams. But we can go on with the tale: grapes, peaches, plums, cherries—all these are the transformed ovaries of flowers, with no confusing accessory parts. So are tomatoes, peppers, eggplants, string beans, which are therefore fruits, botanically speaking. And so also are the seed-pods of peas, of lilies, of milkweeds, the cotton boll, the walnut husk and shell, and many other dry, inedible conainers of seeds.

(To be continued)

A UNIQUE SOLUTION FOR CROWDED HOME GREENHOUSES

By CHARLES MARDEN FITCH

Mr. Fitch, a resident of Mamaroneck, New York, is a member of The New York Botanical Garden.

DO YOU own a greenhouse, large or small? Even if you do not have one yet, read this article to prepare yourself for the inevitable. There are few home owners who do not wish, secretly or otherwise, for their very own greenhouse.

Fair warning to all who plan to build a greenhouse—and confirmation of a problem of those who already own one —it will be overcrowded! From every beam will hang baskets, pots, cans, slabs, and logs holding bromeliads, orchids, gesneriads, begonias, and whatever other plant family you enjoy growing. All the benches will be crammed with plants that cannot be thrown out and cannot be given away because all your friends already have them. You will want to grow some new variety, but you will not be able to find adequate space for it.

Gardeners everywhere have one thing in common—an overwhelming interest in growing unusual, attractive, and often exotic plants. Once it was learned that the gesneriads, orchids, bromeliads, and other plant families could be easily cultivated with but slight basic knowledge of their habits and requirements, these tropical beauties began to be widely grown. In recent years such plant families as the gesneriads have become major topics of interest. Orchids, too, have experienced a fantastic upsurge in popularity, since commercial growers have been making an effort to publicize the easy-to-grow kinds.

Many tropical plants will grow in a living-room window satisfactorily for quite some time. However, the majority need a greenhouse atmosphere for continued healthy growth and maximum flowering. Fortunately, manufacturers of greenhouses have begun to market small, compact units within the homeowner's budget. These houses can be obtained in lean-to or free-standing styles which are attractive features when well placed on the home grounds. There are even models which fit on the outside of a large window.

A greenhouse does look bare for the first few months after it is erected. Later, it is difficult to find enough space, for the fascination and joy of growing numerous kinds of tropical or semi-tropical plants leads the hobbyist to stuff the greenhouse to overflowing in less than two growing seasons. Gardening friends and specialty plant societies constantly offer divisions of some "new" plant. Before one is quite aware of what has happened, the greenhouse has no room for another pot, tub, basket, or flat.

The worried grower cries, "There are so many more plants I want to grow, but I can't possibly throw anything out that's alive. And I can't give anything more to my friends; they have space problems too!"

Well, I had this very problem. For some time I did not know what to do with all of the extra bromeliad seedlings I had grown. Then there were orchid divisions, gesneriad rhizomes and tubers in great abundance, begonia cuttings, philodendron offshoots, pots upon pots of sprouted African violet leaves, not to mention coleus, tradescantia, and zebrina propagations.

Finally, in desperation, I began to bring boxes of treasured plants to meetings of botanical and plant societies for free distribution. This partially solved my problem of overcrowding. The members of the societies to which I belong were delighted to receive propagations of unusual things. They were not already possessors of an annex to my collection as were all of my neighbors! No one who visits my home can escape without carrying off a box of plants. Thus I solved my "extra propagations" problem.

However I still did not have quite enough room for many of the plants I wished to grow. The orchid family is so large that it alone can constitute a lifetime interest. There are also the bromeliads or "air-plants" which captured my interest when I first saw them growing on cypress trees in

Florida's vast everglades. Every day catalogs come which excite my gardener's passion for such odd tropicals as the zantedeschias (calla lilies), anthuriums, nepenthes (pitcher plants), and such bulbous items as amaryllis.

More room was needed. I just had to make space in my already crowded lean-to greenhouse.

In my home there are wide picture windows. Why was all this growing space going to waste? Here was the answer!

A trip to the local garden supply store resulted in the purchase of six plastic window boxes, each about four feet long and six inches wide.

An evening was all it took to construct inconspicuous shelf supports below the window sill. The next day I had over twenty-four more feet of sunny growing space. I filled the window boxes with exploded mica or vermiculite to provide constant humidity and moisture around the clay pots.

We decided these prominent new window boxes were to be filled only with especially beautiful plants from the greenhouse. When the gloxinias opened their buds under the greenhouse bench, they would be given a place of honor in the living-room window box. Orchids, usually rather plain plants when not in bloom, could be grown to perfection in the humid, sunny greenhouse and brought forth when in glorious bloom for proud display inside our home.

Foliage plants such as caladiums, coleus, philodendrons, and ferns are grown into healthy specimens in our ten-by-six foot lean-to greenhouse, and all winter long our home is filled with only the most perfectly groomed plants. Orchids look especially beautiful when displayed in front of complementary foliage plants. Space-consuming bulbs can be brought into flower and enjoyed indoors only while they are at their best.

Gradually the greenhouse has become devoid of all flowering plants. Every plant, when it is in full bloom, has found its way into our living-room window boxes. This is just as well, since the greenhouse can not be seen from indoors anyway.

Now our home is a greenhouse in itself, and the constantly rotating plants provide new pictures *inside* the picture windows. During the winter we gaze over orchid blooms to watch birds at the feeders which are covered with snow. In the summer cool caladiums enjoy the window boxes which are then shaded by the foliage of oaks.

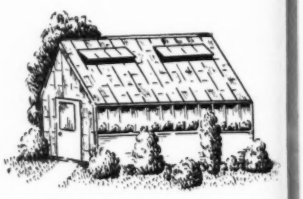
Delicate blooms last even longer on plants in our living-room than they do in our greenhouse. The greenhouse has a constant humidity of perhaps seventy-five to eighty per cent which is fine for healthy growth but tends to shorten the time the blooms are in good condition. In the drier, slightly cooler atmosphere of our living-room window boxes I have had some hybrid cypripediums or paphiopedilums (lady-slipper orchids) hold their blooms in perfect splendor for over eighty days. It is not uncommon for some of our dendrobium blooms to last two months in winter in a sunny window.

My small lean-to greenhouse is kept at a tropical temperature. (The majority of hobbyists' greenhouses are kept between semi-tropical and tropical temperatures, which permit them to grow with ease the more exotic plants.) The temperature does not go below 64° during winter nights except under the benches where, with the aid of fluorescent lights, I grow such cool-loving plants as geraniums, ferns, and the lovely *Eucharis amazonica* or Amazon-lily.

With this rotation system of greenhouse to window box, I find that it is possible for me to grow a surprising number of plants. My extra propagations still go to plant societies where I meet friendly people interested in growing unusual plants. These fellow gardeners supply me with cuttings of plants new to my collection, which I am now able to accommodate.

If you are faced with a space problem in your greenhouse (and what gardener isn't if he has a glasshouse!) try my system of turning the living-room into a plant show-case. You will be thrilled by the extra space it gives you, the added experience of constantly enjoying blooming plants at close daily range, and the compliments from friends about your greenhouse home!

A GREENHOUSE ON A SHOESTRING



By BRUCE H. KIRK

Mr. Kirk is a member of the Market Development and Customer Service Section of the Film Department, E. I. du Pont de Nemours and Company, Wilmington, Delaware. He talked on this subject at the annual meeting of the Men's Garden Clubs of America at Ashville, North Carolina, in June 1960, from which this article has been developed.

YOU MAY be surprised to learn, as I was, that far from being a modern innovation, the greenhouse dates back more than two thousand years. Historians tell us that the ancient Romans practiced the art of forcing fruits and vegetables in pits or cellars which were covered with slabs of transparent mineral, such as mica. They even had air-conditioning—heat was supplied through the natural fermentation of manure.

It must have been the Roman legions that carried the idea into northern Europe, for there are historical references to attempts to grow fruits, such as the orange and grape, in climates far north of their natural habitat. Grapes were trained to the south side of walls and buildings and protected by crude lean-tos of glazed sash. These were not adequate for winter culture, but served to make the summer and fall conditions similar to those farther south.

Orange trees, which had to be protected in winter, were completely enclosed in a framework which was covered with wooden shutters and heated by stone fireplaces. Glass was not used in these structures, but the shutters were removed in summer to allow the trees to receive sunlight directly. A house of this type, built early in the seventeenth century in Heidelberg, Germany, is described as being thirty-two feet wide by some four hundred feet long and sheltering four hundred small orange trees.

The evolution of the greenhouse came about through a combination of these two early ideas. In the early part of the eighteenth century glass roofs on complete structures were found to be practicable, and so the real forerunner of the modern greenhouse came into being. Heated glass-

houses—or stove houses, as they were called—appeared in this country in the latter part of the eighteenth century. These were of the shed-roof type, having a solid north wall and a glass roof sloping southward. Heating passed through the house from an outdoor fireplace by brick flues. Steam and hot-water heating were in use in the early 1800s.

The industrial expansion in the United States that followed the Civil War carried greenhouse construction forward. Statistics from the United States Census report only one commercial greenhouse before 1800; only three before 1820; and only one hundred and seventy-eight in 1860. By 1890 there were more than forty-six hundred establishments, covering almost forty million square feet and valued at forty million dollars. The 1940 Census showed over two hundred million square feet under glass. The 1950 Census shows one hundred and sixty-five million square feet of greenhouses for growing flowers and about sixty-one million for growing vegetables.

With this rapid growth came improvements and refinements in greenhouse design and construction, advancements in the science of horticulture, and an interest in greenhouses for pursuing horticultural hobbies.

It is not surprising that when cheaper and better ways for growing crops were sought, plastic films were considered. While there was some use of plastic-coated wire as a substitute glazing material before World War II, a real interest in plastic materials did not occur until the early 1950s, when several researchers in Europe and in the United States began to experiment with polyethylene film.

Polyethylene film gained favor because it is inexpensive and because its properties make it an extremely versatile material for many horticultural uses. These include thermal lining of glass greenhouses, glazing for greenhouses, coldframes and hotbeds, mulch, silo covers, pond and irrigation ditch liners, and tarpaulins. The film has one basic disadvantage: it deteriorates rapidly under intense sunlight. It is therefore limited as a glazing film to seasonal use; six to nine months if used during the winter, and one to three months if used during the summer. Because of this basic disadvantage, it was natural that steps would be taken to develop longer-lasting plastic films for greenhouse use.

After several years of intensive research and development, tests and evaluation, it was evident that Type W weatherable "Mylar" polyester film was a real breakthrough as a tough, durable film for outdoor glazing applications. Weatherable "Mylar" is the strongest of all plastic films, with a tensile strength roughly one-third that of machine steel. It has remarkable resistance to acids and solvents, is serviceable under extremes of temperature in any climate, is unaffected by bacteria and fungi, will not become baggy with changes in temperature and humidity, and has the toughness to withstand the punishment of most hail-storms. The durability of weatherable "Mylar" under exposure to Florida's sun has been demonstrated to be four to seven years; four years in a 45° exposure facing south and seven years in a vertical exposure.

Success of plastic films for glazing greenhouses depends largely on how well the film is fastened to the structure and the soundness of the structure itself. Most growers have shown their ingenuity in erecting a structure which is reasonably sound.

However, with four-to-seven-year weatherable film, it was necessary to find the answers to certain questions in order to ensure satisfactory performance for the life of the film. There was little knowledge of what angle of roof was best to shed snow and moisture from condensation; there was little information on the design of the frame, and on what spacing was required between rafters. No one really knew how this new plastic film would behave in a high wind.

Research was directed along several avenues and included field installations with commercial growers over the United States and with a number of universities. A program of wind-tunnel tests was carried out at the University of Maryland. The wind-tunnel tests were vital for determining how to properly apply weatherable "Mylar" so that it would withstand the forces of severe storms. These tests were conducted on typical roof panels on a greenhouse model and under conditions simulating the most severe winds encountered outdoors. Tests included wind velocities as high as one hundred and twenty miles per hour.

The development program showed that the proper way to install weatherable "Mylar" polyester film is lengthwise on the roof, with the film overlapping shingle-fashion at each successive run. The basic advantages for lengthwise installation are: a) The film can be pulled "drum" tight, thus reducing "film-flexing" with wind. b) No film edges are under battenstrips. c) No nail holes occur near film edges, thus reducing the possibility of nail-hole tears. d) It is faster and easier than most other methods of installation. e) It gives a neat appearance.

In 1956 a hobby greenhouse was built of weatherable "Mylar" polyester film, which was then still in development. This greenhouse measures 15 x 30 feet and is of 2 x 2 and 2 x 4 redwood, with rafters spaced twenty-four inches apart. The film was installed lengthwise with a six-inch overlap; ordinary plaster lath was used to hold the film to the rafters. A 45° roof slope was used—this was based on the early work on plastic greenhouses done at the University of Kentucky. An inside film layer of polyethylene was installed to save heat and reduce condensation drip.

Roof ventilators were built in the greenhouse, according to the original design; but it has since been found preferable to eliminate the roof ventilators and to air the greenhouse with a ventilator in one end and an exhaust fan in the other, controlled by a thermostat. A simple space heater (using natural gas) was provided, and fans were added within the greenhouse to distribute the heat uniformly. In winter the exhaust fan is blocked off with plastic film, and the interior fans and ventilator prove adequate for circulating fresh air. The owner, a scientist, has commented that growing conditions have been ideal.

It cost about two hundred dollars for the materials for building the shell and the film for glazing, or about forty-five cents per square foot of ground area. The lumber was redwood, which made the material cost appreciably higher than if the greenhouse had been constructed of pine or fir; either pine or fir is suitable when treated with wood preservative. Approximately eighty man-hours were required to build the shell and cover it with film.

Additional costs were about one hundred and twenty-five

(Continued on page 43)

"BETTER DAHLIAS" ARE NOT EASY TO GROW

By PAUL HALE

Mr. Hale is Editor of the *Bulletin of the Central States Dahlia Society.*

"WHAT IS the cloth for?" "I see you shade your plants from the hot sun." "You have surely gone to a lot of expense and trouble." These are typical of the questions and remarks I hear when uninitiated visitors come to my cloth house. My answer is always the same: this extra trouble and expense enables me to grow "better dahlias."

The term "cloth house" is a general one. Many types of material are used to cover frameworks over dahlia patches. "Aster cloth" is the most common, but some growers even go to the expense of covering with a fine mesh screen wire or a nylon mesh.

The meaning of the term "better dahlia" is sensed by the visitor the very minute he steps inside the cloth house. To one who has never seen dahlias growing under cloth, I explain that a cloth house produces more luxuriant foliage, longer stems, bigger blooms, more perfect and refined blooms, and more blooms per plant.

A cloth house has many advantages, which are seldom recognized because most people think only of shade. There is cloth on the sides and top of the cloth house; so moisture evaporated from the soil and transpired by the plants is conserved. Higher humidity causes a more luxuriant development of foliage, and this results in better growth and health than does sun-dried or wind-burned foliage.

Cloth breaks the force of the wind and rain. A driving rain is reduced to a gentle mist, and a hot summer wind is slowed down to a breeze that will not break plants nor burn foliage.

Certainly cloth reduces the direct rays of the sun, and this reduces foliage burn and makes the stem grow longer.

Cloth definitely keeps out leaf hoppers, grasshoppers, cucumber beetles, borers, and cutworms.

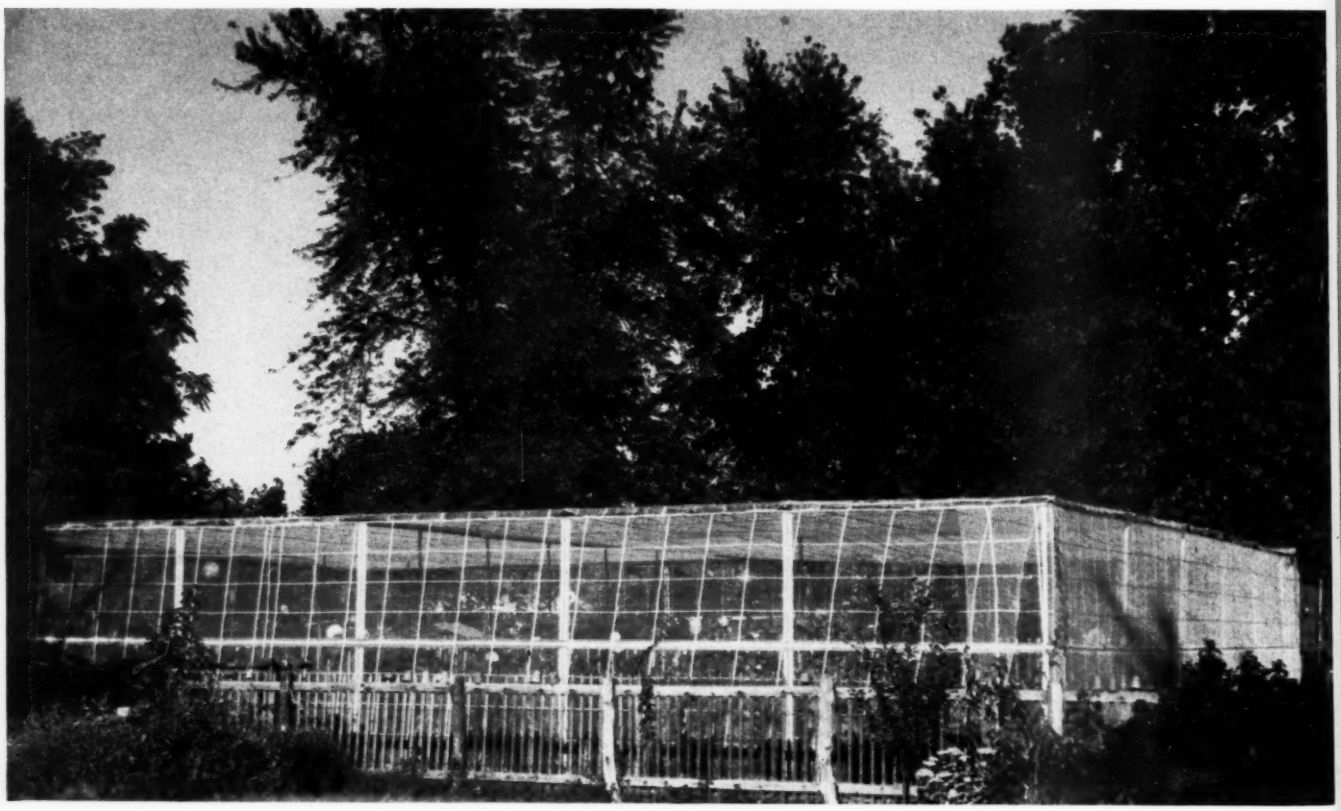
Another advantage is the longer growing season that a cloth house offers. I have weathered two frosts that wiped out other growers' dahlias, and thus gained from three to four additional weeks of growth and blooms.

The question arises, "Are there any disadvantages to a cloth house?" I reply, "Yes, but disadvantages are fewer although highly significant."

Cloth is not cheap, and it costs more each year; the same may be said for the wooden or pipe framework that must be maintained and repaired. Also, it takes time to build a cloth house and to annually install and remove the cloth. A further difficulty experienced in a cloth house is that while it wards off the larger insect pests, it offers the perfect conditions for red spider and plant lice. A grower must continue his spraying program to kill the spider mite. Slugs seek the cool humidity a cloth house offers, and they must be combated.

Another aspect that must be considered is the soil in a

This cloth house measures forty-five feet by fifty feet by nine feet high. It is neat and clean in outward appearance, and within there is a beautiful display of dahlias.



cloth house. Once the house is built, the grower is stuck with the soil inside. Rotation is no longer possible, and care must be taken to maintain the necessary nutrient elements in proper balance. Nutrients must be constantly replaced but caution must be exercised not to supply too much chemical fertilizer lest heavy applications should ruin the soil.

Perhaps the reader has now made up his mind whether or not a cloth house is worth all the trouble. For those who believe it is, the remainder of this article may be helpful.

The selection of the site is most important. The site should be far enough from trees and shrubs to avoid root competition, yet within a reasonable distance because they offer a good windbreak. Reasonably good, well-drained soil and full sun are the most important requirements.

Dahlia cloth houses vary in size, shape, and construction as do other structures, but essentially they consist of a framework covered with cloth. A wooden framework is the more economical: but if one can afford the additional expense, a pipe framework has the advantage of longer life with little or no replacement. My cloth house consists of treated posts set four feet in the ground, with two-by-four uprights mounted to the posts, and one-by-four cross strips with galvanized wire to support the top. The system of wire crisscrossing the roof and sides is a "must," because it provides a means of anchoring the cloth with small "twists" of wire. If the cloth is not anchored in this manner, it will billow with every breeze.

For covering, I use aster cloth, which is a closely woven cotton cloth considerably finer than either nylon or wire screening. Aster cloth is reinforced every nine inches both ways by half-inch-wide bands of thread pulled together. These bands offer strength and a means of anchoring the cloth to the crisscross wire support. Several firms make a cloth of this type. It is the same as that used by the growers of Burley tobacco in the southern states. It costs extra to have the strips sewn together into one big piece for the top, but it is to the grower's advantage to spend the money if only for the time saved in installation.

So much for the why, where, with what, and how to build a dahlia house. The house may be "standard" or "de luxe." Some growers have a watering system, lights, and space for a chair and table where they can relax among their beloved dahlias and sip a refreshing drink as they listen to the strains of Bach or Beethoven. I'll forego these elaborate extras until the four Hale children have been educated and are gone from home.

My cloth house is definitely a luxury, a luxury I fully enjoy, for it has elevated me to the élite circle of experts who regularly top the shows with the best dahlia flowers.

The dahlia has come a long way since it was first noticed by the Spanish naturalist Hernandez, who had been sent to Mexico by King Philip II to study the natural history of that country. To the casual observer the plant the Spaniard found in the mountains of Mexico in the sixteenth century, and which still grows there, bears little resemblance to the dahlias grown today.

In 1789 seeds of acocti—the native name by which the plant was then known—were sent to physic and botanic gardens in Europe. Some of the seeds reached Andreas Dahl, a Swedish botanist and student of Linnaeus. Dahl displayed such keen interest in the plant and its culture and development, that the species was later named *Dahlia* in his honor.

Greater perfection of bloom, straighter and larger stems, more luxurious foliage, and more blooms to a plant are the rewards of growing dahlias in a cloth house. The petals of this bloom of 'Judith' reflex toward the stem and form a good "ball."

The wild species was for a time known as *D. variabilis;* subsequently the earlier name *D. pinnata* was substituted. This is the species from which thousands of varieties have been bred.

From *D. juarezii,* discovered in Mexico in 1879, the cactus-flowered forms have been developed. The Editor.

GREENHOUSE (Continued from page 41)

dollars for the heating equipment with a thermostat and about one hundred dollars for the ventilating equipment, including the fan. Home-made benches were built of surplus materials, for which no costs are available. The cost of this greenhouse then, excluding labor which was provided by the hobbyist, came to under one dollar per square foot. Tying-in the heating of the greenhouse to the home heating system obviously would reduce the total cost.

Many amateur gardeners prefer to build their own greenhouses and design them to suit their particular needs. Basic information in construction and glazing is to be found in a folder entitled "Suggestions for Glazing with Weatherable 'Mylar' Type W."

For those gardeners who are not complete "do-it-yourself" enthusiasts, a prefabricated kit-greenhouse is available from the Turner Equipment Company, Goldsboro, North Carolina. Other interesting greenhouses using plastic film are to be had from leading greenhouse manufacturers.

PLANT PHYSIOLOGY AT THE GARDEN

A Personal Confession

By RICHARD M. KLEIN

Dr. Klein is Alfred H. Caspary Curator of Plant Physiology at The New York Botanical Garden.

I THINK THAT my fate as a plant physiologist was sealed when I first learned that plants are made up of cells. The almost infinite permutations by which these irregularly shaped units are built up into the divergent forms that we see as leaves, stems, and flowers stimulated a curiosity which has not yet abated.

Plant physiology is operationally defined as the study of the mechanisms whereby plants do things. The key words here are "mechanisms" and "do"—and the choice of special fields of research is most frequently determined by the personal preferences of the individual. In my own case, I was initially enthralled by the possibility that a study of plant chemistry could provide insight into the mechanisms that controlled the genesis of plant form. As a beginning graduate-student in botany, I seriously considered plant biochemistry as a career. In preparation for this, I was awarded an appointment in the laboratory of the late Prof. E. S. G. Barrón, an authority on metabolic biochemistry, while continuing my studies in the Department of Botany at the University of Chicago. Together with my botany professor, Dr. G. K. K. Link, I spent over two years studying the enzyme pathways by which the cells of the potato tuber produce the energy required for life. Later, and for an entirely different reason, we studied the intermediary metabolism of the tomato stem—a research problem which occupied about fifteen months.

After the excitement of writing up our results and seeing them published had subsided, I decided to straighten up my files; during this chore I went through my notebooks containing the data upon which these two papers were based. Out of curiosity (and to procrastinate, for I dislike going through files), I casually compared the tables, graphs, and histograms that expressed the results of our work on potato tuber tissue and tomato stem tissue. I was immediately struck by the similarity between the two pieces of research and letting the clean-up wait, I decided to pursue this comparison. After several hours my initial suspicion was confirmed. Step by step, enzyme by enzyme, and substrate by substrate—the results were almost exactly the same!

Now, I knew that a potato tuber is, morphologically, a stem, and I also knew that both *Solanum tuberosus* and *Lycopersicon esculentum* are in the family *Solanaceae* and are, in fact, very closely related. Yet, anyone knows that tomato stems are aerial and are photosynthetic and that potato tubers are subterranean, usually do not carry on photosynthesis and, clearly, are storage organs. Freshman texts state that the major carbohydrate in the cells of the tomato stem is sucrose, and even a botany graduate-student knows that potato tuber cells are full of starch. No one confuses the two. Yet, on the basis of our three and a half years of research, as expressed in precise tables and curves, I could not tell a potato from a tomato. At this point. I left biochemistry.

An examination of the variety of subjects that might have the intellectual excitement which a career in plant physiology can provide, indicated a number of intriguing sub-disciplines. Photosynthesis—the study of the mechanisms leading to the formation of compounds containing available energy—was, to me, too close to biochemistry. Other fields, such as the mechanisms of ion uptake, translocation of water and solutes, nitrogen metabolism, and transpiration, were not "my cup of tea." And so I seemed to be drawn to the field which, for want of a better term, is called "growth and development."

Developmental plant physiology is an ill-defined group of scientific disciplines with several tails currently big enough to wag the body. Several of these subgroups are extensively investigated by a large number of scientists. The biosynthesis, movement, interrelations, and mode of action of the auxins (including indole-3-acetic acid, 2,4-dichlorophenoxyacetic acid, etc.); the newer but allied studies of gibberellic acid and kinetin, the role of radiation in devel-

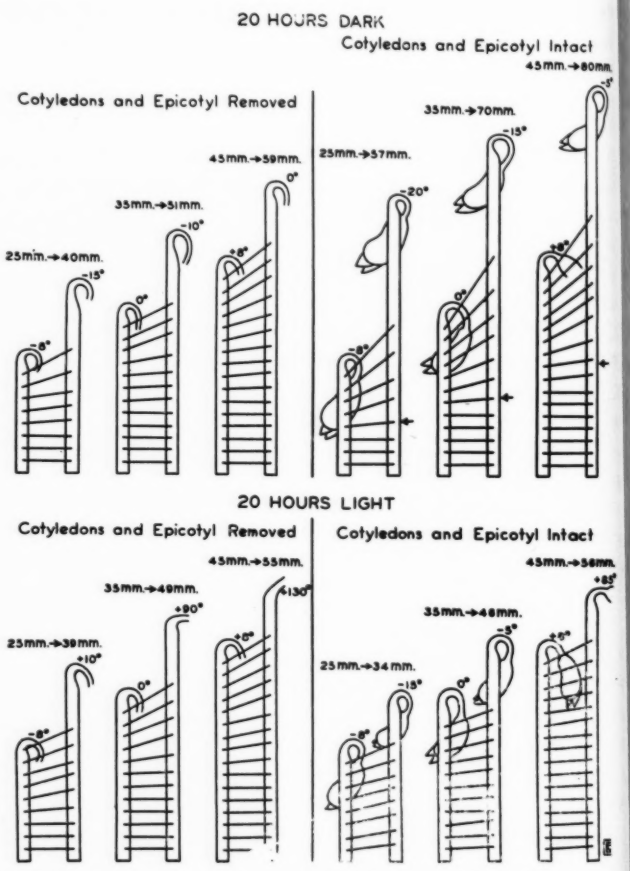


FIGURE 1. Diagram of the growth of bean seedlings showing the zones of growth under conditions of light or darkness. (Drawing by C. C. Clare, Jr.)

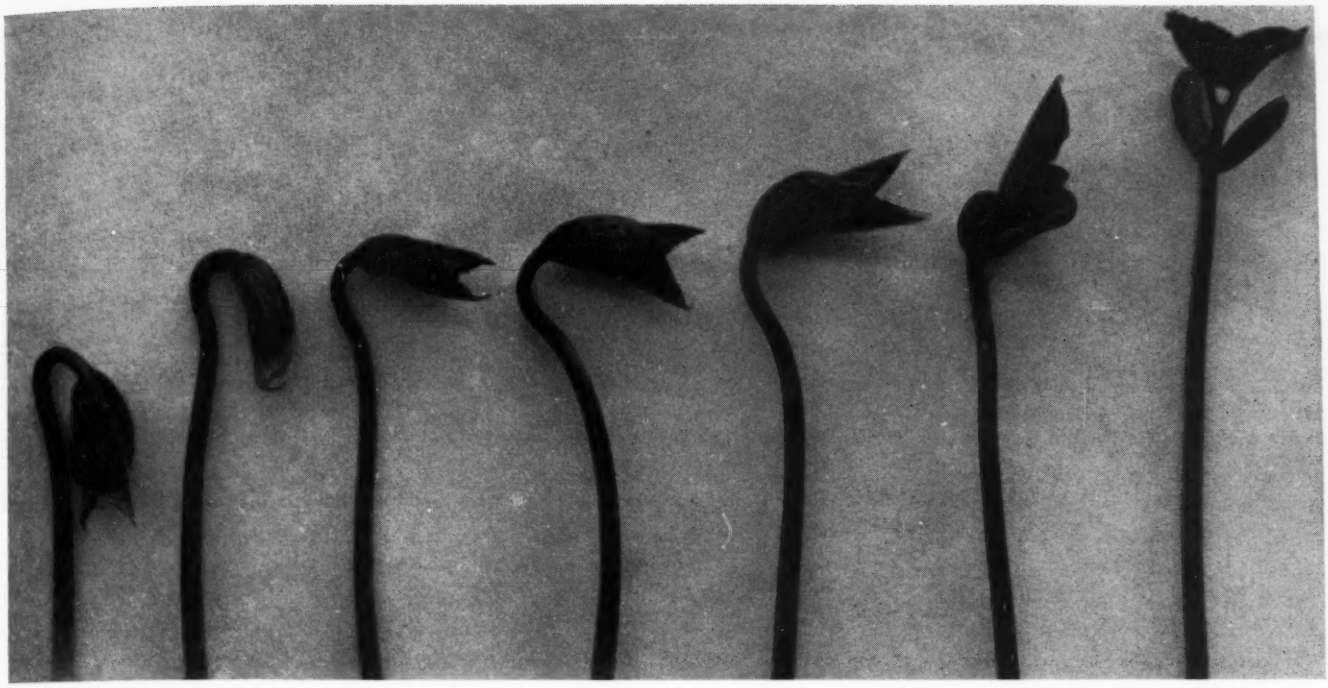


FIGURE 2. Stages in the elongation and maturation of bean seedlings. The stages illustrated require about four to five days.

opment, the interplay between genetic composition and growth, and aspects of vitamin metabolism, each occupy the attention of developmental biologists. There are, of course, the precise equivalent of these interests among zoologists and microbiologists.

Being a "horizontal" discipline—that is, a bridge between many of the somewhat isolated "vertical" or separate disciplines in botany—the field of growth and development places a premium on the capacity to relate many findings from seemingly diverse subjects directly to the developmental processes of plants. Anatomy, morphology, taxonomy, mycology, and biochemistry are all germane to development. This integration is, of course, not unique to developmental physiology. The taxonomists use information obtained by physiologists and morphologists in their studies on the interrelations among groups of plants; ecologists use the data supplied by taxonomists, physiologists, and microbiologists in clarifying the interrelations among individuals; and pathologists build on the knowledge of mycologists, physiologists, entomologists, and others in working out host-parasite complexes. Similarly, I wanted to be able to relate the accumulated information from other fields of botany and cell biology to the development of the individual plant.

Obviously, the selection of experimental material is as broad as the plant kingdom and the topics selected are as diverse as are plants. Yet, there are several points that tend to restrict one's choice. It is generally assumed that information or facts obtained through the examination of one plant may be of pertinence to others. This is the pragmatic rationale for many studies and, as we have seen, it has paid off handsomely. Our knowledge of heredity is based on peas, fruit flies, corn, mice, pink bread-mold (*Neurospora*), and the colon bacterium, *Escherischia coli* together with its virus parasites (bacteriophage). From these heterogeneous organisms, valid predictions are made throughout the world on the outcome of crosses of many organisms including man. In this way, knowledge is confirmed, codified, and used. For these reasons, the selection of a test organism and the phenomenon to be studied are canalized so that the information may be of pertinence for many organisms and for many phenomena. To investigate mechanisms of root growth, I pick a plant with a "typical" root system (unless I specifically want to study the specialized or unusual). This has led physiologists to use relatively few "guinea pigs". Peas, beans, corn, tomatoes, sunflowers, and oats are favorite plants. Very frequently, a plant may have special features which make it ideal for particular experiments. *Citrus* responds dramatically to mineral deficiencies; the pollen of *Ginkgo* produces a very rapidly growing tissue culture; the nuclear structure of *Spirogyra* is easily visualized; and the stem tips of *Dryopteris* are amenable to precise surgical studies of the apical meristem. Fungi, too, present certain special features which make them ideal for studying the interplay between genetic capacity and growth processes.

These statements can best be illustrated by a description of some of the research now in progress in our laboratory.

As is true of all children, I became fascinated by the germination of bean seeds and the early development of the resulting bean plant. The first apparent change is the uptake of water into the cells and into the intercellular spaces. Biochemically, this is a period in which enzyme activity begins with attendant increases in the rate of the breakdown of food reserves (hydrolysis) and increases in the production of energy (respiration). The root begins to elongate by cell enlargement, pierces the seed coats, and the seed is said to have germinated.

At first all cell divisions in the seedling are localized in the root tip as it pushes into the soil. Cell elongation is

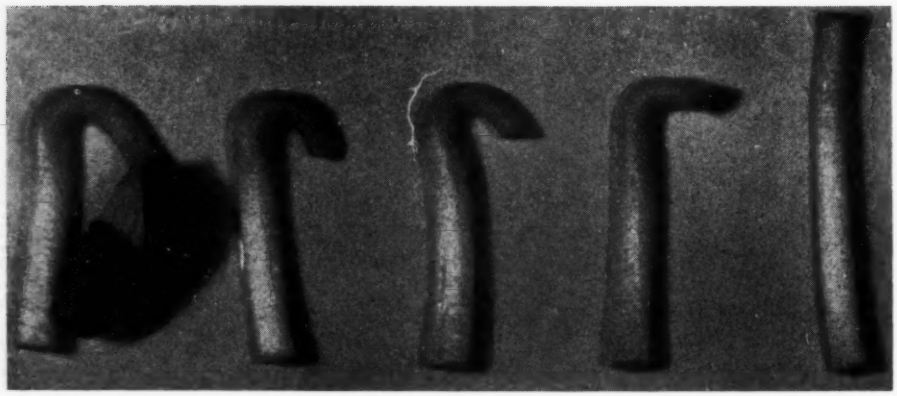


FIGURE 3. Left. The opening of the plumular hook of dark-grown bean seedlings. The stages shown in the photograph require about twenty hours after treatment with dim red light.

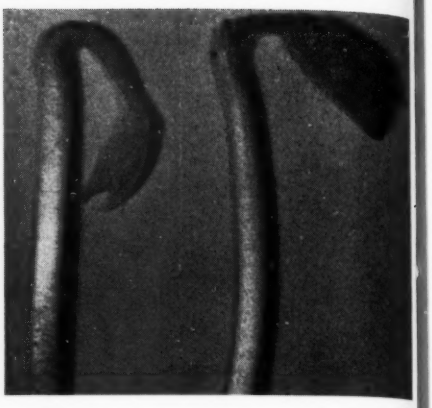


FIGURE 4. Right. The effect of one minute of dim red light on the straightening of the plumular hook and the expansion of the seed leaves of dark-grown bean seedlings. Photograph taken twelve hours after illumination of seedling on the right. The seedling on the left was taken from an unilluminated plant.

primarily responsible for the early growth of the shoot—most of this growth being localized in the lower stem (hypocotyl). While still in the seed, the hypocotyl is arched; as it emerges and elongates, the cotyledons are literally pulled out of the soil. This arched portion of the hypocotyl, the plumular hook, persists until the hypocotyl reaches almost mature length. The seed leaves then expand, the upper stem (epicotyl) begins to elongate, and the young seedling then straightens out. Seedling development is thus a linked series of events in the multicellular system we call an individual plant. Personally, I am still more than somewhat awed at the magnificent execution of these manifold maneuvers that almost invariably result in the development of a "perfectly ordinary" bean seedling.

For study, seed germination and seedling growth must be broken down into "part events." Our laboratory has chosen three of them for our investigations. These are the control of the elongation of the hypocotyl, the straightening of the plumular hook, and the expansion of the primary leaves. Fortunately, we had available a good deal of background information on these processes upon which we could build and, as you will see, this background information was derived from a number of disciplines. From anatomical studies, we knew that the elongation of the hypocotyl is due primarily, but not exclusively, to uniform elongation of cells of all the tissues; the straightening of the plumular hook is due *solely* to the differential elongation of a relatively few cells on the concave side of the arch, and the expansion of the seed leaves is, again, due primarly to cell enlargement. In elongation and arch straightening, the enlargement of the involved cells is exclusively in one direction, parallel to the long axis of the shoot; leaf expansion is two-dimensional, parallel to the surface of the leaf. Genetic studies have indicated that the extent of hypocotyl elongation and the rate of leaf expansion are ultimately controlled by specific genes. Available data suggest that the preceived development involves profound biochemical changes, and several workers have pointed out the precise correspondence of the structural details of the stem with well-known engineering principles of stress and strain.

The elongation of the hypocotyl is, of course, a time-dependent process. Furthermore, the whole hypocotyl doesn't just elongate at one time or elongate at random throughout its length. We took bean seedlings of several different lengths and marked off equal intervals on the stem with a complex piece of laboratory apparatus (a dime-store comb dipped into India ink). Growth could be followed by measuring the changes in the distance between ink dots. As seen in figure 1, the most basal segment of the smallest (25 mm.) plants examined had already ceased elongation when our study began; elongation of a longer segment of the 35 mm. seedlings was complete; and almost half of the largest seedlings had reached mature length. This suggested that elongation is, in fact, a wave process in which cells at the base of the hypocotyl complete their elongation before the cells in the middle, until ultimately the ones nearest the cotyledons elongate. This has been confirmed by the elegant technique of time-lapse photography. The presence or absence of light and the presence or absence of the cotyledons and epicotyl profoundly affect hypocotyl elongation.

Several investigators had previously demonstrated that the elongation of the most apical portion of the hypocotyl required sugar (primarily transported from the cotyledons after the hydrolysis of the starch reserves) and hormones obtained by the downward transport of auxin formed in the epicotyl. Our researches confirmed these findings and supplemented them with the discovery that gibberellic acid was also stimulatory. Clearly, if elongation starts at the base of the shoot and auxin, sugar, and gibberellic acid are formed on the apex of the plant, there must be a gradient of these growth regulators from apex down. Apparently the basal segments elongate first, because the intervening tissues transport the growth regulators downwards very rapidly. Although it is not yet proven, it seems possible that the concentration of these factors is initially too high in the apical segments to allow elongation and that this concentration-gradient decreases with age. Rates of production, blocks to downward transport, and enzymatic destruction must also be considered.

At the moment, we are trying to find out if the mature basal segments are capable of further elongation. That is, are they still responsive growth substances (which would indicate that their supply from the apex had been cut off) or are they absolutely recalcitrant to growth-promoting sub-

stances (which would indicate that the limiting factor in their growth is not the supply of growth substances)? The problem is somewhat complicated by the fact that we know that sugar, auxin, and gibberellic acid are not the only growth substances involved and that the several growth substances acting together in a single phase of any growth process have optimum concentration ratios. If, as we now believe, the "normal" mature length of a cell is not necessarily representative of the inherent capacity of that cell, these experiments will have extended our knowledge of the range of reactability of cells.

As I pointed out above, the straightening of the bean seedling is accomplished by the unidirectional elongation of a relatively few number of cells on the concave side of the arch of the plumular hook. In a seedling grown in light, this straightening occurs only after the hypocotyl reaches almost mature length and starts just about the time the seed leaves begin to enlarge (Figure 2). If the seedling is grown in complete darkness, the hypocotyl will elongate enormously (five to ten times that of light-grown seedlings), but the hook persists and the seed leaves remain embryonic. It was found by others that a very small "shot" of light would trigger both these growth processes. Once light-activated, the processes are light-independent. The effective wavelengths were centered about the red end of the visible spectrum (6600 Å). This positive effect of red light could be completely negated by far-red light (7600 Å)—an exciting finding in view of the fact that red and far-red light are the same pair of wave-lengths involved in the germination of seeds, in flowering, in the budding of mosses, and many other growth processes in both plants and animals. The elongation of the few cells on the bottom of the arch of bean plants becomes a model for investigating the role of red light in cells of all types. In our case, we wanted to use the plumular hook as a test system to see if we could find out just what the red light does within the cells.

From earlier work, at the Smithsonian Institute, we found that the opening of the hook could be measured quantitatively by excising plumular hooks of dark-grown bean plants in a standard fashion and measuring the angle of the hook, which represents the extent of cell elongation (Figure 3). With this precise method, several approaches to this multi-faceted question can be formulated. We can study the quantitative interrelations (time, intensity, quality) of light and cell elongation. We can attempt to partially or fully substitute chemicals for red light to see if any particular growth factor or factors will "replace" the necessity for the light, thus giving us an insight into the biochemical basis for light action. We can also investigate the effects of other radiations, temperatures, etc., on the opening of the hook.

Our results, admittedly far from complete, suggest that the red light activates several enzyme systems which synthesize at least four growth factors which, together, can completely replace the red light. An interesting sidelight on this conclusion was the unexpected finding that one of these growth factors is what I have called an "auxin recalcitrance" factor. That is, our evidence suggests that one limiting factor in hook opening is the presence in the zone of elongation of an excessive amount of auxin. As long as the apex of the plant continues to produce and to transport these high concentrations of auxin to the hypocotyl, hook opening is suppressed. Red light, or ultra-violet radiation, somehow reduces the biologically effective concentration of auxin to a stimulatory level. As we expected, application of a compound which specifically antagonizes auxins *in situ* will permit hook opening. Additional evidence for this phenomenon is obtained when the source of the auxin (cotyledons, young leaves, and terminal meristem) is removed (see Figure 1 for measurements of hook angles in plants with, and without their "heads"). How do the presumed "light substitutes" work? What is the action of ultra-violet light in auxin recalcitrance? Does the cobalt ion (one of the light substitutes) interrelate with auxin utilization? Why does elevated temperature (a physical light substitute) work? Can the finding on auxin recalcitrance be related *in vivo* to the observation that the hook opens when leaves and epicotyl enlarge? Preliminary observations indicate that there may be a profound reduction at this time in the capacity of the shoot cells to transport auxin.

At the moment, we haven't much information on the red-light-induced enlargement of the seed leaves (Figure 4). Work in several laboratories has shown that the red-light effect is the major physical factor and that chemical substitution for light is possible. We are studying the responses of the leaves to X-rays, because we believe that this particular test system may supply badly needed information on the responses of plant cells to ionizing and visible radiation. Here, bean leaves are nearly ideal for determining growth responses to several types of irradiation in the presence of specific chemicals.

Another problem currently under investigation will, I believe, illustrate the sequential nature of research. About a year ago, I invited a high school student, Emarita Caputo, to work in our laboratory for a Science Fair Project (see *The Garden Journal,* Vol. 10, No. 4, p. 157). Her interests led us to design experiments to determine the effect of zinc ions on the growth of tissue cultures—a problem which had previously received some attention only in France. Upon the completion of her problem, with library research and discussions with Dr. Jacques Lipetz (who was then working in the Garden's Research Laboratory), it seemed probable that the results Miss Caputo obtained were directly applicable to another botanical question.

Back in the 1940s, Professor Folke Skoog at the University of Wisconsin postulated that adequate concentrations of zinc ion were necessary for normal plant development because zinc was required to maintain optimal concentrations of auxin. It was not clear at that time whether the zinc was needed for auxin synthesis, to control auxin destruction, or to facilitate auxin transport. During 1960, however, a report was published in the *Journal of Bacteriology* showing that zinc ion was a "cofactor" for the enzyme that causes the condensation of the amino acid serine with indole to form the amino acid tryptophan. Now, most of the available evidence suggested that the primary precursor of auxin is tryptophan, and it seemed logical that the plant required zinc to obtain the tryptophan needed for auxin synthesis. If all this was true, slow-growing zinc-deficient cells could be stimulated into normal growth by supplying zinc, tryptophan, or auxin. Using tissue cultures, we found that this was indeed the case. Yet, tissue cultures are a rather unique test system, and it seemed desirable to confirm these results

using intact plants. Together with Dr. Lipetz (who is now at the Rockefeller Institute) we surveyed the literature to find a plant which could be grown with relative ease, was very sensitive to zinc deficencies, and showed obvious developmental patterns which were characteristic of zinc deficiency. Orange trees were our choice, particularly when we found out that zinc deficiencies were perceived as reductions in the size of leaves (leaf expansion is known to involve auxin) and reduction in the extension of internodes (which also implicated auxin). Genetically uniform seeds were provided by Dr. W. P. Bitters of the Citrus Experiment Station in Riverside, California. Pounds and pounds of sand were washed in tap water, boiling acid, and distilled water to remove all zinc, and the seeds were planted.

At this writing, the seedlings are up and zinc-containing and zinc-free nutrient solutions are being supplied to the plants at regular intervals. When clear zinc-deficiency symptoms are evident, appropriate numbers of plants will be treated with zinc, tryptophan or auxin. Frankly, I am most interested to see if the results check with our findings with tissue cultures. If they do, a causal relation between a mineral and a plant hormone will have been established for an isolated cell system (tissue cultures) and for intact plants. If agreement is not obtained, then our theory is wrong or incomplete. "The proof of the pudding is in the eating."

Sir Cecil Hinschelwood, Nobel Laureate and President of the Royal Society of London, said, "Mystery and fascination have no end, the pursuit of knowledge has no limit." The research projects that I have mentioned exhaust neither the range nor the scope of developmental plant physiology. When, and if, we obtain the answers to the questions we are now asking, these answers will form the basis for other questions. In addition, there are equally intriguing questions which are yet to be answered. Some of these are being investigated in our laboratory. Why do some seeds require light for germination, while others are inhibited by light? What is the relation between cell enlargement and cell division in the growth of roots? Why doess green light suppress cell division?

I think it is fair to ask where all this is leading and what is its purpose. Obviously, I want to satisfy my own curiosity about the mechanisms that underlie the phenomena that I am studying. I must share these findings and concepts with other people, professional colleagues and interested laymen, so that they, too, will know more about the world in which we all live. In turn, I shall be the recipient of the knowledge that they have gathered and, together we shall have "staved off the inroads of intellectual chaos." Although information which any of us may obtain may eventually be useful for man's physical well-being, this potential practical value cannot be even the indirect motivation for true scientific work. Science, by definition, is the accumulation of verifiable information about the universe. It is, in a most real sense, a search for knowledge solely for the sake of knowledge. The historian, the student of eighteenth-century French literature, and the philologist are climbing the same intellectual mountains as are the scientists and for exactly the same reason: "Because they are there." As long as man remains curious about the world in which he lives and feels uncomfortable about gaps in his knowledge, there will be people who will continue the search.

CHEMISTRY IN A BOTANICAL GARDEN

By MARJORIE ANCHEL

Dr. Anchel is Research Associate at The New York Botanical Garden.

FOR A biochemist, a research institute connected with a botanical garden offers opportunities of an unusual kind. These have to do both with the material available for investigation and with one's associates. There is essentially no limit to the biochemical and chemical problems that a collection of microorganisms and higher plants represents. And everyday contact with specialists in the biological aspects of the problems offers a source of first-hand advice on the "care and feeding" of these organisms, as well as of other information about them which is essential for biochemical work. It also makes possible the kind of close cooperation necessary for a particular type of investigation—one that bridges otherwise widely separated scientific disciplines. Research in this Laboratory offers several examples.

The biochemical problems first investigated had to do with the isolation in pure form of antibiotic principles from the Basidiomycete group of fungi, and with chemical studies of these compounds. The New York Botanical Garden maintains a very large collection of Basidiomycetes. A survey of these had been carried out by Dr. William J. Robbins, Dr. Annette Hervey, and Dr. Frederick W. Kavanagh, and a considerable number of them were found to have antibiotic activity. The problems of producing, detecting, isolating, and characterizing the antibiotic principles involved close co-operation between microbiologist and chemist. This is generally true. The microbiologist often cannot determine whether he is dealing with a single active compound and rarely can isolate and purify it. The chemist is dependent on the microbiologist for detection of new sources of antibiotic principles, for methods of producing these in quantity, and, at least initially, for microbiological assays as a means of following the separation of the compounds in question.

The earlier work with antibiotically active fungi resulted in the isolation of a group of new antibiotics, including ochracic acid, nemotin, nemotinic acid, illudin M and illudin S, marasmic acid, p-methoxytoluquinone, pleuromutilin, fomecins A and B, drosophilins A, C, and D, diatretynes 1 and 2, and biformin. All these have been at least partly characterized chemically, and the complete chemical structure of some has been elucidated. Pure samples of these compounds were sent to other laboratories for various types of biological testing. While at least one of them has some interest as a possible anti-tumor agent and is still under study, none proved entirely appropriate for practical application.

However, interest in these compounds is by no means limited to the possibility of their therapeutic usefulness. It is apparent that they can furnish material for studies of the relationship of chemical structure to biological activity, a problem of both practical and theoretical significance. When the active material has been isolated in pure form and its structure determined, the biological effect of chemical modifications can be studied, and related compounds with more desirable properties sometimes can be synthesized.

Because of their diversity, antibiotic fungal metabolites

are of importance also for reasons less related to their practical application. First of all, they present unusual problems in biosynthesis (that is, the question of how the organism makes the compound.) For example, drosophilin A, the structure of which has been completely elucidated, is one of the most highly chlorinated natural organic compounds known. The biosynthesis of this compound is an interesting problem in chlorine metabolism. Illudin M, illudin S, and marasmic acid are compounds belonging to the group of sesquiterpenes. Terpenoid compounds include a large group of natural products and are represented in vitamins, hormones, and essential oils. Production of this type of compound by a Basidiomycete offers the desirable opportunity for a study of its biosynthesis, in which a microorganism is used as the experimental animal.

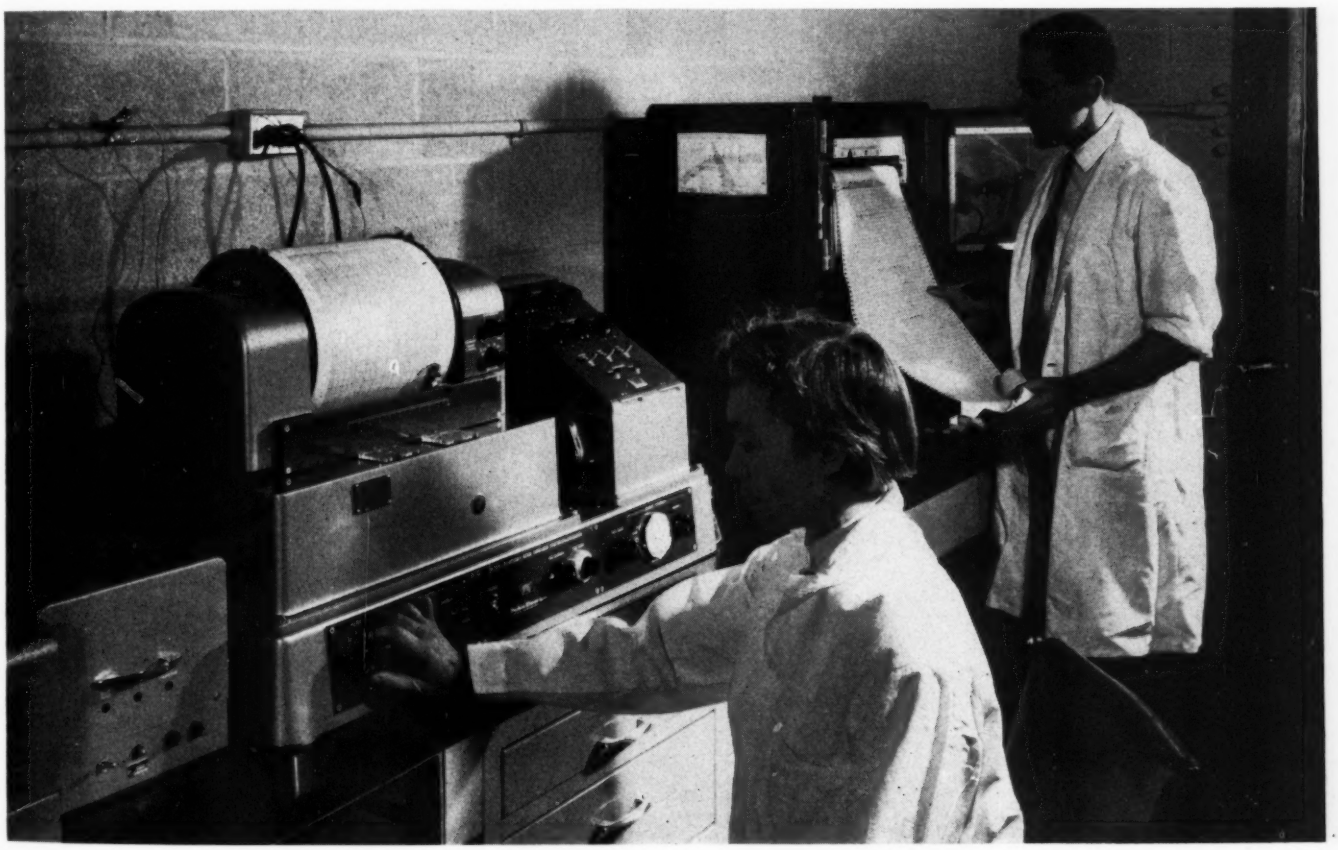
A further reason for the importance of antibiotic fungal metabolites is that many of them have unusual, if not unique chemical structures. Such compounds are of particular interest to the organic chemist because of their chemical behavior, and to the biochemist from the point of view of their metabolism. An example of this is fomecin, the chemistry of which is so far only partly known. Its behavior is, in many respects, unorthodox, and final elucidation of its structure will undoubtedly contribute information of future use to organic chemistry.

Perhaps the most unexpected group of compounds isolated as a result of this work are the polyacetylenes. These compounds were not previously known to occur in Basidiomycetes. The rare examples of them that were previously isolated came from higher plants. Acetylenic compounds were considered as mere curiosities from a biological standpoint, and at least on one occasion an incorrect alternate structure was assigned to one of them because of reluctance to accept the existence of the acetylenic bond in nature. It is now known that polyacetylenes are common in two large biological groups, namely, fungi and higher plants. Nevertheless, as natural products polyacetylenes are oddities, both because of their highly unstable nature and because of the almost complete absence of information on their biosynthesis. These considerations, combined with the frequency of their occurrence, have stimulated investigation of their metabolism in this and in other laboratories.

It was in connection with the occurrence of these compounds that another study was begun which involved microbiological, mycological, taxonomic, and chemical collaboration. Maintenance of the Garden's Basidiomycete collection, referred to earlier, involved periodic "transfer" to fresh agar slants. When the most recent transfer was begun about a year ago by Dr. Hervey, with the assistance of Mrs. Miyako Li, it seemed like a good opportunity to investigate more extensively the distribution of polyacetylenic metabolites in these organisms. Polyacetylenes show a very characteristic absorption of ultraviolet light and can be spotted readily by using a spectrophotometer. "Transfer" of the culture collection offered an opportune occasion for obtaining a sample of each culture for this purpose.

Because we wished to investigate the metabolism of the diatretynes, it was of special interest to determine which

Dr. Marjorie Anchel operates the infra-red spectrophotometer, while Dr. Trevor McMorris examines a spectrum from the ultra-violet recording spectrophotometer in the Research Laboratory of The New York Botanical Garden.



organisms produced these particular polyacetylenes. Dr. William Silverman, who was then in our group, observed that the known diatretyne producers were related taxonomically. This suggested the possibility that occurrence of these compounds, as well as polyacetylenes generally, might be relevant to a kind of biochemical taxonomy. That is, if it were found that distribution of polyacetylenes followed, in general, a taxonomic classification based on morphological characteristics, then in some instances the presence of polyacetylenes might support one classification rather than another, or might help to assign the position of an organism whose classification was in doubt. This type of study is being done in collaboration with Dr. Clark Rogerson and appears to show some promise.

Some of the problems mentioned are being studied more intensively. Dr. Nalini Valanju, a post-doctoral biochemist, is collaborating in a study of metabolic relationships of the diatretynes, using radioactive tracers. Dr. Trevor McMorris, a post-doctoral organic chemist, is collaborating on determination of the chemical structure of some of the partly characterized metabolites that have been isolated. Assisting in the work of this group are Miss Hulda Shaw and Bernard Russ.

Microbiological Research at the Garden

By ANNETTE HERVEY

Dr. Hervey is Research Associate at The New York Botanical Garden.

THE DEVELOPMENT of a collection of stock cultures of fungi and other organisms, mostly Basidiomycetes, was initiated as a result of a survey of the latter for antibacterial (antibiotic) activity. The Basidiomycetes include mushrooms, shelf fungi, and other well-known fungi. We also have fungi belonging to the Phycomycetes, Ascomycetes, Fungi Imperfecti, and Actinomycetes. Our collection of Basidiomycetes, obtained from many sources in this country and from abroad, is considered outstanding.

Studies on these organisms resulted in a number of publications from our laboratories, beginning in 1945 (by W. J. Robbins, Frederick Kavanagh, Annette Hervey, Mary Stebbins, Majorie Anchel, and others). In addition to providing reference material for our own staff members (mycologists, physiologists, plant pathologists, and chemists), our cultures have aroused the interests of microbiologists and biochemists in other institutions and in many fields. For example, Dr. F. F. Nord of Fordham University has been using Basidiomycetes in his studies on the metabolism of compounds which might be lignin precursors. Dr. H. H. Zinsser, Department of Urology, Columbia University Medical Center, recently asked for *Collybia velutipes,* a fungus

Dr. Annette Hervey, left foreground, and Mrs. Miyako Li, right background, are engaged in a periodic "transfer" of the Garden's Basidiomycete collection into fresh agar slants.

that is used as an analytical tool in the development of a clinical test for the oxalate content of urine. A personal telephone communication indicates that our having the desired culture was responsible for a gain of several months in the development of this test. It may be noted that The New York Botanical Garden is the only convenient major source of cultures for the large numbers of schools and colleges in this area.

The maintenance of a collection of stock cultures of some three thousand microorganisms presents many difficulties. The organisms must be kept alive and free from contamination. In the past, it was necessary to transfer our stock cultures at monthly intervals to prevent their drying out, a very time-consuming process. In 1947, we started to place our stock cultures under oil. Briefly, the method was to coat cultures grown on agar slants in test tubes with sterile Parke Davis mineral oil. The cultures were then stored at 15° C. Bits of mycelium can easily be fished out from below the oil to start new cultures as needed. The oil method is the only one suitable for the long-time preservation of cultures that do not easily form spores. This technique has proved to be especially suitable for the preservation of Basidiomycetes, which make up the major portion of our collection. We now have some eight thousand tubes, prepared at different times from 1947 on, containing living organisms under oil; some are duplicates, some triplicates.

We are interested in testing the viability of our stock cultures placed under oil in 1947. It would be of great interest to know how well these cultures have survived under oil for some fourteen years. A recent test in our laboratory of cultures eight and nine years under oil indicated that ninety-seven per cent of the first one thousand were viable on the first transfer to two per cent malt agar slants. As far as we know, we are the only laboratory conducting viability studies of this type.

We are also interested in the nutritional problems of microorganisms that are difficult to cultivate. Many organisms grow and reproduce well when furnished with food of known chemical composition. Some organisms grow only in nature and have not been successfully cultivated in the laboratory. Intensive studies are being made on a group of Basidiomycetes that will grow in a medium of known chemical composition only if it is supplemented with some natural material such as wood extract, malt, tomato juice, or yeast extract. What is it in these natural materials that permits the organisms to grow?

The organism to be tested is grown in duplicate or triplicate in 25 ml. of liquid medium in 125 ml. Erlenmeyer flasks at 20-25° C for a period of two weeks. The basal medium contains mineral salts, dextrose, casein hydrolysate, mixtures of purines, pyrimidines, vitamins, and minor elements. This medium is used alone or supplemented with various amounts of natural substances. Flasks are inoculated with pieces of mycelium about 1 mm. in diameter taken from the edges of cultures grown on agar. Dry weights are determined by treating the mycelium with ethanol, filtering into Gooch crucibles, and drying at 100° C.

The effect of the natural supplements varies with the fungus and the supplement. It is believed that wood, tomato, and malt extract contain unidentified growth substances which satisfy partial deficiencies from which some of these fungi suffer. The ultimate answer would be found in the isolation of such growth factors, if they exist.

In an attempt to isolate and identify these growth factors, we are fortunate in collaborating with a group of biochemists at Merck and Company. We have recently tested some two hundred and fifty of their preparations at various concentrations on *Polyporus schweinitzii.* This is but one example of the usefulness of an organism of this type as a valuable tool in the discovery of new growth substances.

Although the influence of light on the development of the fungi is well-known, the nature of its effect is not understood. We have found one of our Basidiomycetes, *Poria ambigua,* an especially favorable subject for investigation, as both growth of this organism and the formation of basidiospores by it are profoundly affected by light.

STUDIES ON SELECTIVE PATHOGENICITY

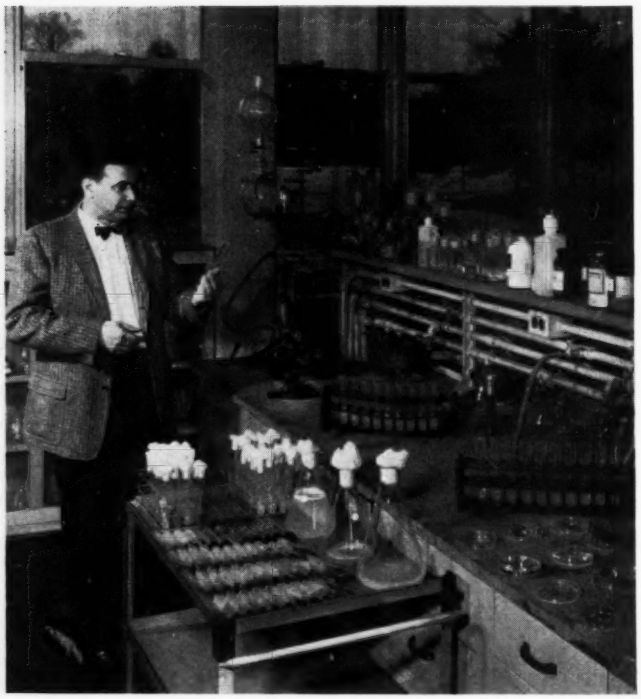
By DAVID DAVIS

Dr. Davis is a Visiting Research Associate at The New York Botanical Garden.

ALTHOUGH OUR knowledge of the nature and control of disease in plants and animals has vastly increased since the germ theory was set forth some one hundred years ago, we still have not answered a fundamental question about the interaction of the host and parasite. The question can be stated as follows: Why is the capacity of a bacterium, fungus, virus, or other microorganism to cause disease restricted to a select group of hosts and often to only one species?

At the Research Laboratory of The New York Botanical Garden, we are investigating this phenomenon, which is known as selective pathogenicity, through the use of a plant disease caused by a fungus. The disease, commonly known as Fusarium wilt, is characterized by blighting of the foliage. The microorganism that causes the disease is *Fusarium oxysporum,* a fungus that attacks a variety of plants ranging from clover to banana. However, and most significantly, if the *Fusarium* that is isolated from a diseased banana plant is placed in contact with clover, or any other plant, it will fail to cause disease. Conversely, the *Fusarium* that causes wilt in clover cannot affect banana. The two parasites are indistinguishable from each other morphologically—that is, in form or structure—as well as in their nutritional requirements; and to date the only reliable method of distinguishing the different parasitic forms of *Fusarium oxysporum* is through their selective pathogenicity. Over thirty pathogenic forms of this fungus are known, and each one is capable of attacking a specific host or group of closely related hosts.

There are two alternative explanations for this phenomenon: either the host stimulates the particular parasite or the parasite reduces the resistance of the particular host. In other words, both the host and the parasite must be examined to obtain the answer to this problem. Dr. E. W. Buxton at the Rothamsted Experimental Station in England studied the role of the host. He demonstrated that the roots of a variety of pea susceptible to the form of *Fusarium* that



Dr. David Davis inspects a test tube of a host seedling, growing in an agar-agar solution, which he will inoculate with the microorganism *Fusarium oxysporum*.

attacks pea plants produces an exudate that stimulates the growth of the fungus, while a resistant pea variety exudes substances that inhibit the growth of *Fusarium*. Examining the part played by the parasite, researchers at the University of Wisconsin demonstrated that extracts of the appropriate strains of *Fusarium oxysporum*, grown in artificial culture, induce symptoms of disease in specific hosts. The extract from the cotton *Fusarium* produced symptoms in the cotton plant not unlike those that are produced by the parasite under natural conditions of infection. The same extract had no effect on other plants. Equivalent results were obtained with the fusaria that attack cabbage and radish. These observations led the investigators at the University of Wisconsin to suggest that the selectively toxic extracts also aid in establishing the specific pathogen in the tissue of its host. Since these observations have neither been verified, nor their ramifications fully studied, we intend pursuing them further.

Other host products that may play a significant role in selective pathogenicity are the plant hormones. Plant hormones, like animal hormones, are internal secretions that are concerned with many of the critical processes of growth and reproduction. Researchers at the Connecticut Agricultural Experiment Station demonstrated that plant-growth hormones (auxins) increased resistance to *Fusarium* wilt in tomato. In contrast, certain anti-auxins increased susceptibility to disease in tomato. The auxins must have been acting through some indirect mechanism. First, they were not toxic to the fungus by themselves when they were introduced into artificial culture media. Second, susceptibility was decreased as the interval between the treatment of tomato with auxins and the inoculation of tomato with *Fusarium* was increased. The data suggest that plant-growth hormones increase resistance to disease by altering the metabolism of the host in a direction which is unfavorable for the development of disease. The mechanism by which the auxins retarded disease remained obscure for a number of years.

We now have a rational explanation of how auxins affect susceptibility to disease; they apparently retard disease by mediating the metabolism of pectins in the host. Pectins are the glue-like substances that bind the individual cells together, thereby giving the plant rigidity. Auxins determine the extent to which calcium-pectin bonds are formed. When the auxin content is very high, the pectin is in the form of a calcium salt. Calcium pectates more readily resist digestion by the pectolytic enzymes that are produced by *Fusarium* than do the non-calcified pectins. Since the advance of *Fusarium* in the host depends on the degradation of pectin, auxins retard disease by increasing the relative number of non-digestible calcium-pectate molecules.

Initial studies at The New York Botanical Garden on selective pathogenicity in *Fusarium oxysporum* are being carried out to develop methods and models that will facilitate future physiological and biochemical investigations. For this purpose, we are developing a technique of culture which involves growing plants in test tubes one inch in diameter and six inches in length. Besides saving space, this technique has other advantages: a) The time and labor spent in handling the plants are reduced. b) Growing conditions are kept uniform, since the test tubes are placed in artificial light with rigidly controlled temperatures. c) The host seedlings are grown on a substrate of agar-agar containing mineral nutrients, and this eliminates the many unknowns present when soil is used. d) The plants can readily be grown under sterile conditions. This has a great advantage over experiments performed with plants grown in unsterilized soil, since we can examine the effects of *Fusarium* or its products on the host without interference from other microorganisms or their products. e) Fortuitously, we found that certain species of plants, namely cabbage, carnation, and radish, when grown in test tubes, show disease symptoms within eight to fourteen days after inoculation with the parasite. This is in sharp contrast to the time required for the appearance of symptoms in nature. Under normal greenhouse and field conditions, there is a three-to-six week period of incubation, depending on the host and parasite in question, before symptoms appear.

The test-tube culture technique has yet another advantage. We anticipate fractionating *Fusarium* extracts to ascertain their role in selective pathogenicity, the smaller the test plant and the area to accommodate it, the less the volume of material needed to determine physiological responses. This can be a very important factor in facilitating chemical isolation since in many instances the chemist can supply only very small samples for biological testing. As a corollary to our work with plants grown in test tubes, we intend to reinforce our results by similar experiments on plants grown and inoculated in the greenhouse.

An understanding of the mechanism of selective pathenogicity in a plant disease may improve our knowledge of the relation between the host and the parasite in diseases of animal and man. When these relationships are better understood, we can more readily devise methods of preventing and curing disease.

GUIDE TO TREES

at The New York Botanical Garden

AREA I

By T. H. EVERETT

Assistant Director (Horticulture)

In The New York Botanical Garden are many thousands of individual trees, many hundreds of different kinds. This is a guide to 55 kinds (112 individuals) growing within a very few minutes walk from the main gate. To locate these trees, turn right immediately after you enter the main gate. The trees are on both sides of this road.

Maximum heights given in this guide are those occasionally attained under ideal conditions, and most usually refer to specimens growing in their native habitats. Cultivated specimens in regions other than their native habitat are usually considerably lower even at maturity. This is especially true of natives of western North America, Europe, and Asia. Most conifers (cone-bearing evergreens, such as firs, spruces, and Douglas-fir) do not really thrive under city conditions. For their best development, they need a less polluted atmosphere. Because of this many specimens of these in The New York Botanical Garden are less vigorous and less shapely than others in suburban and country areas.

1. Fraxinus pennsylvanica lanceolata —GREEN ASH (family *Oleaceae*). Native of eastern North America. Maximum height 60 ft. Has a rather narrow round-topped head and pinnate, opposite leaves which turn golden in fall. Its inconspicuous flowers appear in late spring. It differs from the red ash *(Fraxinus pennsylvanica)* in that its young branches, petioles, and flower panicles are smooth rather than conspicuously pubescent, but intermediates between these two kinds occur. This is a good shade tree, especially valued in the Plains states. It has been much used for shelterbelts. It develops best in rich, fairly moist soil but will tolerate dry as well as wet locations. The green ash is the state tree of North Dakota. Its wood is used for tool handles, furniture, cooperage, baskets, crates, sporting goods, railroad ties, veneer, and fuel.

2. Prunus serrulata 'Hata-zakura'—JAPANESE FLOWERING CHERRY (family *Rosaceae*). Horticultural variety of a species native to Japan, China, and Korea. Maximum height 20 ft. This is one of the numerous and closely similar single white-flowered varieties of Japanese flowering cherry. It forms a spreading head and blooms in early spring. Landscape use and cultural needs as for number 10A.

3. Corylus colurna—TURKISH HAZELNUT (family *Betulaceae*). Native of southeastern Europe and western Asia. Maximum height 80 ft. A stately tree, of regular pyramidal outline, well worth planting as an ornamental. Its fruits (nuts) are edible. Male and female flowers are borne separately on the same tree, the former in slender catkins conspicuous throughout winter and spring, the latter enclosed in small scaly buds from which, in spring, the red styles protrude. The nuts, in clusters of three or more, are remarkable for the appearance of the 1½ in.-wide husks which surround them. These are fringed with many long narrow pointed lobes. *Corylus colurna* and the nearly related *Corylus chinensis* are the largest trees in the genus. •

3A. Malus—FLOWERING CRAB-APPLE (family *Rosaceae*). This (at the time of writing) is unidentified as to species or variety. Flowering crab-apples are excellent small, spring-flowering trees in any good soil in full sun.

4. Prunus serrulata 'Meigetsu'—JAPANESE FLOWERING CHERRY (family *Rosaceae*). Horticultural variety of a species native of Japan, China, and Korea. The statements made regarding number 2 apply to this tree also.

5. Platanus occidentalis — BUTTONWOOD, SYCAMORE, AMERICAN PLANE (family *Platanaceae*). Native of eastern North America. Maximum height 160 ft. Parent of the London plane (number 12). The most massive American tree, it develops a tall straight trunk and a broad or round-topped-oblong head. Its bark flakes in patches showing white or cream-colored areas beneath; the upper parts of the trunk and the major limbs are often entirely white and smooth. The seed balls are usually solitary, rarely in pairs. A good shade tree, but more difficult to transplant and more susceptible to disease than the London plane. It does best in rich, moist, slightly acid soil. Its wood is used for furniture, boxes, crates, railroad ties, cooperage, fence posts, and fuel. Not to be confused with the sycamore-maple (number 6). This particular specimen is, at the time of writing, in poor condition presumably as a result of unavoidable damage done to its roots during the construction of the nearby Research Laboratory building. If it becomes necessary to remove it, it will be replaced by another of the same species.

6. Acer pseudo-platanus—SYCAMORE MAPLE (family *Aceraceae*). Native of Europe and western Asia. Maximum height 100 ft. Called sycamore in England and plane in Scotland, but very different from the true planes *(Platanus)* of which the American sycamore *(Platanus occidentalis)* is one. Compare with trees numbers 5 and 12 in this guide. Note opposite leaves of maple, alternate leaves of plane, twin winged seeds of maple, hanging seed balls of plane, evident axillary buds of maple, axillary buds enclosed by petiole in plane. The sycamore maple grows vigorously, forms a large spreading head, and is well adapted for exposed locations and seaside planting. It thrives best in a medium moist fertile soil, grows in any ordinary soil. Its foliage does not color well in fall. Its wood is white and is used for turnery and pattern molds. •

7. Abies homolepis. See number 64.

8. Picea abies—NORWAY SPRUCE (family *Pinaceae*). Native of Europe. Maximum height 150 ft. A pyramidal evergreen with wide-spreading branches, usually drooping branchlets, and rich green foliage. Commonly planted as an ornamental, it grows rapidly but in our climate does not ordinarily live more than 40 years and often becomes straggly and unattractive earlier. Given ample space, full sun, and an unpolluted atmosphere, it develops into an imposing symmetrical tree, truly beautiful during its first 25-30 years. Numerous fine specimens may be seen in nearby counties. It thrives in a wide variety of soils and is a good windbreak and shelterbelt tree. Many dwarf and otherwise horticulturally interesting varieties of this species are cultivated; many good specimens of these are in the Montgomery Conifer Collection at The New York Botanical Garden. It is an important European source of lumber and paper pulp.

9. Quercus borealis maxima—RED OAK (family *Fagaceae*). Native of eastern North America. Maximum height 150 ft. Is taller and has larger acorns with shallower cups than the northern red oak (number 46) of which it is a variety. It forms a majestic specimen with stout, spreading branches and a broad, rounded head. In fall its foliage turns dark red. This oak grows rapidly and thrives best in moist fertile soil. Its wood, similar to that of the northern red oak (number 46), is used for the same purposes.

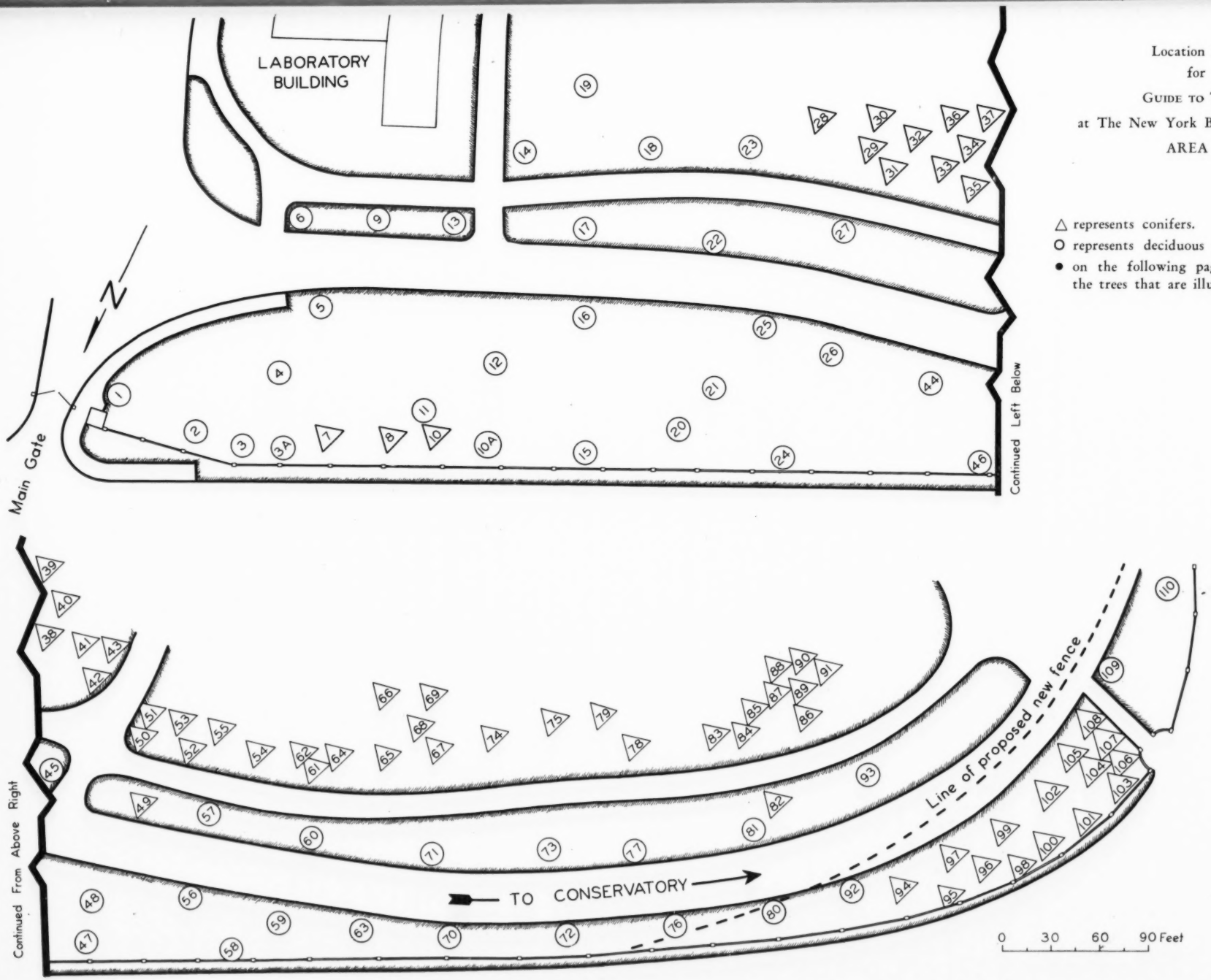
10. Pseudotsuga taxifolia. See number 82.

10A. Prunus serrulata 'Taki-nioi'—JAPANESE FLOWERING CHERRY (family *Rosaceae*). Horticultural varity of a species native of Japan China, and Korea. Maximum height 12 ft. or slightly more. This, one of the smaller-growing Japanese cherries, forms a spreading head which in early spring is covered with single white fragrant flowers. Its Japanese varietal name means "fragrant cascade." An admirable ornamental for a lawn specimen and for other landscape purposes, it succeeds in well-drained, fairly rich soil in full sun.

11. Prunus serrulata 'Fugenzo'—JAPANESE

Location Map
for
GUIDE TO TREES
at The New York Botanical Garden
AREA I

△ represents conifers.
O represents deciduous trees.
● on the following pages indicates the trees that are illustrated.



FLOWERING CHERRY (family *Rosaceae*). Horticultural variety of a species native of Japan, China, and Korea. Maximum height 20 ft. This variety, which has been cultivated in Japan for more than 500 years, forms a spreading head and has copper-colored young foliage. Its double pink flowers are borne in abundance in spring. Its Japanese name means "Goddess on a White Elephant." Landscape and cultural needs as for number 10A.

12. Platanus acerifolia — LONDON PLANE (family *Platanaceae*). A hybrid between *Platanus orientalis* and *Platanus occidentalis*. Maximum height 120 ft. This magnificent tree is a favorite for street planting in New York and in many other of the world's cities. It is easier to transplant, more tolerant of difficult environments, and much more disease-resistant than our native *Platanus occidentalis* (number 5). It withstands repeated hard pruning well and by this means can be kept to almost any desired size. The London plane forms a tall, erect trunk and a wide-spreading, rounded head. Its seed balls are usually in pairs, occasionally singly or in threes. Its bark peels in large flakes exposing yellowish areas beneath. When raised from seeds young trees vary in their foliage characteristics, some favoring one parent, some the other. Most, if not all, of the specimens growing in the New York area called oriental plane *(Platanus orientalis)* are really London plane *(Platanus acerifolia)*. The London plane thrives best in rich, moist earth but will grow in a wide variety of soils. Its wood has the same uses as that of buttonwood (number 5). ●

13. Liriodendron tulipifera — TULIP-TREE, TULIP-POPLAR (family *Magnoliaceae*). Native of eastern North America. Maximum height 200 ft. A noble species of pyramidal or oblong outline that in late spring bears large handsome, but not very conspicuous, tuliplike flowers which are green and white with an orange band near the bottom, inside each petal. Long after the flowers have fallen, their remains can be seen at the branch ends as light brown loose conelike or starlike attachments. The leaves are unlike those of any other tree except of its oriental relative, *Liriodendron chinense*. They are four-lobed and are saddle-shaped at their ends. In fall they turn bright yellow. The trunk is tall, straight, and extends into the crown. The tulip-tree needs fertile, fairly moist, well-drained soil. Except when young, it is rather difficult to transplant. It may be used as a shade tree, but it has the fault of being rather susceptible to storm and ice damage, and it begins dropping its leaves in late summer or early fall and continues doing so for a long period. The four rows of trees that border the approaches to the Museum Building of The New York Botanical Garden are tulip-trees. The wood, known as yellow-poplar, is soft and fine-grained. It is used for furniture, boat building, and veneer. The state tree of Kentucky.

14. Juglans nigra—BLACK WALNUT (family *Juglandaceae*). Native of eastern North America. Maximum height 150 ft. Characteristically straight-branched and round-headed with deeply ridged, almost black bark. Leaves alternate and pinnate. Flower greenish, the males in drooping catkins, the females in short spikes at branch ends in spring. Nuts large, thick-shelled, sweet, edible. A good shade and shelterbelt tree but difficult to transplant except when young. It thrives best in moderately moist, rich soil. Evidence supports the popular belief that it is difficult or impossible for many other kinds of plants to prosper under walnut trees, presumably because their roots exude a substance harmful to other plants. Its wood takes a fine polish and is highly valued for furniture, interior finish, and gun stocks. This is the state tree of Iowa.

15. Liquidambar styraciflua. See number 22.

16 and 17. Phellodendron lavallei—CORK TREE (family *Rutaceae*). Native of Japan. Maximum height 45 ft. A picturesque shade tree with wide-spreading branches and thick, corky, deeply fissured bark. Well adapted for use in small home landscapes and tolerant of city conditions. Its handsome deep green, pinnate leaves are marked with minute translucent dots as are those of most plants of the *Rutaceae*. They turn golden-yellow in fall. The tiny yellow-green flowers in large terminal panicles are followed by pea-like berries, at first green, becoming black when ripe. They taste strongly of turpentine. All parts of the tree are strongly aromatic. This tree prospers best in deep rich soil. It withstands transplanting well. ●

18. Carya ovata—SHAGBARK HICKORY (family *Juglandaceae*). Native of eastern North America. Maximum height 120 ft. A rather narrow oblong-topped tree. After it reaches its nut-bearing age it is usually characterized by numerous very conspicuous curved platelike strips of bark hanging loosely from the trunk. (This particular specimen has not developed this "shagginess" to any marked degree). Its compound leaves usually consist of 5 leaflets which turn yellow or yellow-brown in fall. The male flowers are in slender, drooping, branched catkins, the females in terminal spikes. Hickories are readily distinguished from walnuts by the solid pith in their twigs, whereas walnut pith is partitioned crosswise. This species thrives in a variety of soils but grows rather slowly. It is a fine ornamental tree but difficult to transplant except when young. Its thin-shelled, sweet, edible nuts are the hickory nuts of commerce. The hard, heavy wood is valued for tool handles, parts of vehicles, for smoking meats, and as fuel.●

19. Gleditsia triacanthos—HONEY LOCUST, SWEET LOCUST (family *Leguminosae*). Native of eastern North America. Maximum height 140 ft. Graceful broad-branched, loose-headed tree with dainty pinnate or bipinnate foliage. Normally trunk and branches are decorated with large, stout, branched spines of exceedingly vicious appearance, but thornless varieties are cultivated. The spines are morphologically modified branches. The flowers are inconspicuous, not pea-shaped as in most hardy *Leguminosae*, usually unisexual, the sexes in separate racemes, and are followed by long curved or twisted pods containing several seeds surrounded by edible sweet pulp. The pods provide food for livestock. Valued as a shade and shelterbelt tree, the honey locust thrives in any ordinary soil, withstands drought well, transplants easily. The wood is used for fence posts, construction, furniture, and railroad ties.

20. Castanea crenata—JAPANESE CHESTNUT (family *Fagaceae*). Native of Japan. Maximum height 30 ft. An attractive tall shrub or small tree, resistant (but less so than the Chinese chestnut, *Castanea mollissima*) to the chestnut blight disease that destroyed the native American chestnut. The Japanese chestnut begins bearing when about 6 years old. Its nuts, smaller than those of our native *Castanea americana*, are an important food in Japan. The tree has been hybridized with native American castaneas in efforts to produce disease-resistant varieties, but most of those developed are less worthy than the best hybrids between the Chinese chestnut and American kinds. This tree thrives in any fairly good soil that is well drained.

21. Quercus palustris—PIN OAK (family *Fagaceae*). Native of eastern North America. Maximum height 120 ft. A favorite shade and street tree with, when young, a symmetrical rather narrow pyramidal head, and drooping lower branches, and in age a more irregular and oblong outline. Its foliage becomes brilliant red in fall. This oak grows fairly rapidly, is easy to transplant, and requires acid, moderately moist soil. Its wood is used for fuel, charcoal, shingles, and clapboards.

22. Liquidambar styraciflua—SWEET GUM (family *Hamamelidaceae*). Native of eastern North America, Mexico, and parts of Central America. Maximum height 140 ft. A magnificent ornamental tree of symmetrical, pyramidal, or rounded outline. Its slightly fragrant, glossy, maple-shaped leaves, which are alternate on the stems and not in opposite pairs like those of maples, turn a brilliant red in fall. The twigs are reddish, usually with corky ridges. The insignificant flowers appear in globular heads when the new leaves are partly grown. Male and female flowers are usually in separate heads. The females are followed by spiny ball-like fruits which hang on the tree throughout the winter. This tree is rather difficult to transplant, especially in clayey soils. It is resistant to storm damage and thrives in a variety of non-alkaline soils, best in moist but well-drained ones. A very important timber tree; its wood, known as redgum and sapgum, is used for furniture, interior trim, veneer, boxes, and millwork. This tree is the source of storax, a gum used in adhesives, salves, incense, and perfume.

23. Carya cordiformis—BITTERNUT (family *Juglandaceae*). Native of eastern North America. Maximum height 90 ft. A handsome ornamental of fairly rapid growth which forms a rather broad head. Its leaves, of 5-9 leaflets, turn yellow or yellow-brown in fall. Its flowers are essentially like those of the shagbark hickory (number 18). Its nuts have thinner husks than those of shagbark hickory. They are thin-shelled and bitter. Characteristic of this species is the bright yellow color of its winter buds. It thrives best in rich, moist soil but is difficult to transplant except

3. *Corylus colurna*

6. *Acer pseudo-platanus*

12. *Platanus acerifolia*

when young. The wood is used for the same purposes as that of number 18. ●

24. Quercus palustris. See number 21.

25. Gymnocladus dioica—KENTUCKY COFFEE TREE (family *Leguminoseae*). Native of eastern North America. Maximum height 100 ft. A remarkable and picturesque tree which gives light shade and is attractive at all seasons. Its enormous leaves are twice pinnate, unfold late in spring, are first pink but soon turn bronzy green. They become yellow in fall and drop early. The flowers are unisexual or bisexual, greenish and in panicles. Unlike those of most hardy *Leguminosae*, they are regular rather than pea-shaped. The seeds are in large flat reddish pods which remain on the tree all winter. They have been used as a coffee substitute. This tree thrives in rich, moist soil. It is nowhere abundant in the wild. Its wood is handsome and suitable for cabinet work and is durable in contact with soil. ●

26. Prunus persica 'Helen Borchers'—FLOWERING PEACH (family *Rosaceae*). Horticultural variety of the common peach, *Prunus persica*, which is a native of China. Maximum height 15 ft. A lovely, but comparatively short-lived, small spring-flowering shrub or tree that bears an abundance of clear pink flowers 2½ in. in diameter. It thrives best in light, well-drained, fertile soil in full sun and should be pruned rather heavily after flowering. ●

27. Syringa amurensis japonica — (family *Oleaceae*). Native of Japan. Maximum height 30 ft. This unusual lilac, the latest to bloom and the only kind that becomes distinctly a tree, forms a pyramidal rather open head. Its leaves are larger and coarser than those of the common lilac. Its bark is glossy and much like that of a cherry tree. About mid-June or slightly earlier it produces massive panicles of ill-scented, small creamy white flowers. Although the panicles are much larger, they bear a resemblance to those of privet to which shrubs lilacs are botanically closely related. It thrives in any well-drained soil in full sun.

28. Picea pungens argentea — COLORADO SPRUCE variety (family *Pinaceae*). *Picea pungens argentea* is often misnamed Koster's blue spruce. The true Koster's blue spruce has drooping branches and a trunk which, if left unstaked, grows horizontally along the ground. The only difference between this and *Picea pungens glauca* (number 30) is that the foliage of variety *argentea* is more silvery.

29. Picea polita—TIGERTAIL SPRUCE (family *Pinaceae*). Native of Japan. Maximum height 120 ft. An ornamental, rather slow-growing, broad-pyramidal evergreen, symmetrical when young, more irregularly shaped later, distinct because of its stiff, spiny leaves that project from all around its rigid branches except on their under sides where a v-shaped trough or groove separates the foliage. A good kind for planting where space is somewhat limited. It requires the same culture as oriental spruce (number 33), and its wood is useful for the same purposes.

30. Picea pungens glauca — COLORADO SPRUCE variety (family *Pinaceae*). A variety of a species native of Colorado, Utah, Wyoming, and New Mexico. Maximum height 150 ft. This, one of several varieties of *Picea pungens* commonly known as Colorado blue spruce, is distinct and beautiful. It forms a symmetrical, conical head of stiff horizontal branches usually arranged in distinct tiers, has downy young shoots, and rigid, bluish spiny leaves (compare with Engelmann spruce number 39). Like other varieties of Colorado spruce, this thrives in the Northeast and is freely planted in gardens; but, like other varities too, it is at its best during its early life and after 15-20 years is likely to lose lower branches and become ragged. *Picea pungens* and its varieties are very susceptible to certain insect infestations. *Picea pungens glauca* differs from typical *Picea pungens* (the state tree of Colorado and of Utah) in that its foliage is more definitely bluish. The wood of *Picea pungens* and its varieties is similar to that of Engelmann spruce (number 39) and is used for the same purposes.

17. *Phellodendron lavallei*

18. *Carya ovata*

23. *Carya cordiformis*

25. *Gymnocladus dioica*

31. *Picea pungens viridis*

42, 43. *Picea orientalis (left)*
41. *Picea pungens glauca (right)*

31. Picea pungens viridis — COLORADO SPRUCE variety (family *Pinaceae*). The only difference between this and *Picea pungens glauca* (number 30) is that the foliage of variety *viridis* is green. ●

32. Picea omorika—SERBIAN SPRUCE (family *Pinaceae*). Native of southern Europe. Maximum height 100 ft. Rather narrow and pyramidal in outline and one of the hardiest spruces. It grows rather slowly. Its shoots are clothed with short stiff hairs. Its leaves, flat in cross section, are dark green with whitish lines facing the ground. Although facing downwards, the sides of the leaves with white lines are really the upper ones; as with all spruces, the leaves are twisted about 180 degrees. Serbian spruce is one of the very best for landscape use. It requires the same cultural conditions as oriental spruce (number 33). Its wood is used similarly.

33. Picea orientalis — ORIENTAL SPRUCE (family *Pinaceae*). Native of Caucasus and Asia Minor. Maximum height 120 ft. A handsome ornamental that resembles the Norway Spruce (number 8) in outline, but its branches are more slender and its leaves smaller. Its cones are purple when young, later brown. Oriental spruce grows more slowly than Norway spruce and is more compact. For these reasons it should be preferred for planting where space is limited. A fairly rich, moist, but not wet soil suits it best. Its wood is valued for the same purposes as that of Norway spruce.

34. Picea pungens glauca. See number 30.

35. Picea orientalis. See number 33.

36. Picea pungens glauca. See number 30.

37. Picea orientalis. See number 33.

38. Picea pungens glauca. See number 30.

39. Picea engelmannii glauca — ENGLEMANN SPRUCE variety (family *Pinaceae*). Native of western North America. Maximum height 150 ft. This differs from typical Englemann spruce, *Picea engelmannii*, in that its foliage is more distinctly bluish. In other respects it is similar. It forms a narrow pyramidal head with rather slender, spreading branches. Its leaves are flexible and have a strong disagreeable odor when crushed. The young shoots are pubescent. (The closely related Colorado spruce, *Picea pungens*, differs in having hairless shoots and rigid spine-tipped leaves). This is one of the best spruces for planting in the Northeast and one of the most beautiful. It is extremely cold-resistant. It requires the same cultural conditions as oriental spruce (number 33). Its lumber is light, soft, close-grained but not strong. It is used for building, box-making, railroad ties, poles, and fuel. The bark is used for tanning.

40. Picea pungens viridis. See number 31.

41. Picea pungens glauca. See number 30.●

42. Picea orientalis. See number 33. ●

43. Picea orientalis. See number 33. ●

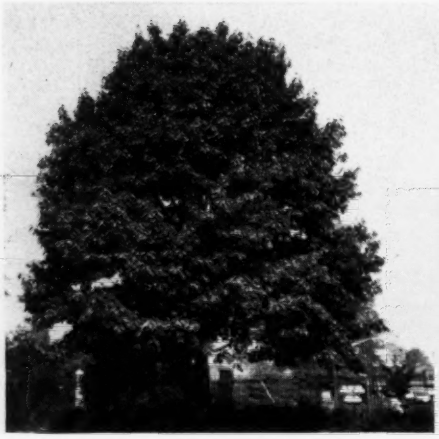
44. Prunus persica variety — WEEPING FLOWERING PEACH (family *Rosaceae*). Horticultural variety of the common peach, *Prunus persica*, a native of China. This single-flowered variety is characterized by its pendulous branches. The remarks made regarding *Prunus persica* 'Helen Borchers' (number 26) apply to this variety, except that its flowers are smaller and are not double.

45. Fraxinus americana — WHITE ASH (family *Oleaceae*). Native of North America. Maximum height 120 ft. Round-topped or pyramidal. Its flowers have no ornamental merit. Its fruits, one-seeded winged samaras, form conspicuous drooping panicles. Like most ashes *Fraxinus americana* has pinnate leaves and large black winter buds. Ashes are among the few common trees that have opposite leaves. A good shade tree for fertile, fairly moist soils. It makes rapid growth

45. *Fraxinus americana*

46. *Quercus borealis*

48. *Chionanthus retusa*



56. *Quercus velutina*

57. *Betula lutea*

58. *Koelreuteria paniculata*

in its early years and is easy to transplant successfully. Its wood is heavy, tough, strong, and is greatly valued for making furniture, oars, tool handles, and for finishing interiors. •

46. Quercus borealis — NORTHERN RED OAK (family *Fagaceae*). Maximum height 75 ft. Native of eastern North America. A broad-spreading, round-topped tree with stout branches and large bristle-pointed leaves that turn dark red in fall. One of the commonest native oaks, it is a fine shade and street tree that grows rapidly and thrives in moist or dryish soil. Its acorn cups enclose about one third of the nut. An important lumber source, the wood is rather porous and not especially resistant to decay. After treatment with preservatives, it is used for railroad ties, and heavy construction. •

47. Celtis sinensis — HACKBERRY (family *Ulmaceae*). Native of China, Japan, and Korea. Maximum height 60 ft. This oriental relative of our native hackberries and of the sugarberry of our South makes a dense, stately, rounded tree but has no very special merit as an ornamental. Its foliage, like that of most hackberries, resembles that of their near botanical relatives, the elms. From elms hackberries are readily distinguished by their fruits which are berry-like, black, purple, yellow, or orange (orange in *Celtis sinensis*), whereas the fruits of elms are dry winged seed-cases (samaras). *Celtis sinensis* thrives in any ordinary soil. Its fruits are reported to be edible.

48. Chionanthus retusa—CHINESE FRINGE-TREE (family *Oleaceae*). Maximum height 30 ft. A rather rare tall shrub or small tree that in late spring bears a profusion of beautiful snow-white, fragrant flowers in broad panicles much shorter than those of our native *Chionanthus virginica*. The panicles terminate the ends of young shoots of the current year's growth, whereas those of the American kind arise directly from upper nodes of stems developed the previous year. The flowers are four-petaled and functionally male or female, not bisexual. This tree is closely related botanically to forsythia, lilac, and privet. The Chinese fringe-tree forms a choice lawn specimen when it has ample room to develop. A moist fertile soil and sunny location suit it. •

49. Abies veitchii — VEITCH'S FIR (family *Pinaceae*). Native of Japan and Manchuria. Maximum height 75 ft. One of the best firs for planting in the eastern states and, when young, one of the most beautiful. It was discovered originally growing on Mount Fujiyama by the English plant collector J. Gould Veitch in 1879. It forms a conical tree, easily distinguished from other firs by its narrow, abrupt-tipped leaves which are directed towards the tips of the branches and more or less curving upwards. They are green above and have bands of intense white beneath. The branchlets are minutely downy. The cones are purple before they ripen. Like those of all firs they are erect, whereas those of spruces hang downwards. Another difference between firs and spruces is that when leaves of the former fall or are pulled off, they part from the stem with a tiny piece of bark attached and leave a smooth scar; whereas spruce needles when detached from the branchlets leave short stubs. Cultural needs and lumber characteristics as for number 64.

50. through 55. Abies homolepis. See number 64.

56. Quercus velutina—BLACK OAK (family *Fagaceae*). Native of eastern North America. Maximum height 150 ft. This tree develops an open, narrow-oval, round-topped head. A fast grower, it thrives best in moderately moist soil. Its leaves, which are widest above their middles, have bristle-tipped lobes. When they unfold in spring, they are soft crimson; in fall they turn dull red and orange-brown. Like others of the black oak group, this species has acorns that ripen in their second year. The inner bark, the linings of the acorn cups, and the meat of the acorns are yellow, for which reasons the tree is sometimes called yellow oak. Its wood is one source of red oak lumber, its bark is used for tanning. •

57. Betula lutea—YELLOW BIRCH (family *Betulaceae*). Native of eastern North America. Maximum height 100 ft. A valuable round-headed forest and ornamental tree, with spreading, often more or less pendulous branches and lustrous, peeling, silvery grey or light orange bark which becomes reddish-brown with age. Bark of young branches is aromatic and somewhat bitter. The leaves are aromatic and turn yellow in fall. Male flowers are in drooping catkins, females in much smaller catkins succeeded by small cones which are conspicuous in fall and early winter. A moist, well-drained light soil suits this species. The wood, close-grained, hard, heavy, and strong, is used for furniture, flooring, boxes, bobbins, fuel, and distillation products. •

58. Koelreuteria paniculata—GOLDENRAIN-TREE (family *Sapindaceae*). Native of China, Korea, and Japan. Maximum height 30 ft. A fairly fast-growing, round-headed tree with fernlike pinnate or bipinnate leaves that do not color attractively in fall, and large panicles of small golden-yellow flowers in summer. The flowers are followed by big, brown, papery-walled, bladderlike pods that persist until fall. This splendid ornamental should be used more frequently in gardens. It thrives in any ordinary soil, is very drought-resistant, and needs a sunny location. A good specimen is located against the front of the Museum Building of The New York Botanical Garden to the left of, as one faces, the main entrance. This tree is planted in great profusion in New Harmony, Ind., and yearly a festival is held there when the trees are in bloom. •

59. Quercus phellos—WILLOW OAK (family *Fagaceae*). Native of eastern North America. Maximum height 100 ft. This splendid shade tree grows fast, is long-lived, and thrives in exposed locations and near the sea. It is easy to transplant and grows well in a variety of soils, but best in fairly moist ones. It forms a conical round-topped head and has long, narrow, unlobed willowlike leaves, very unlike those of most oaks. These turn pale yellow in fall. Belonging to the black oak group, this tree ripens its acorns in their second year. It is one source of red oak lumber. Its wood is strong and heavy. •

60. Populus alba—WHITE POPLAR, ABELE (family *Salicaceae*). Native of Europe and Asia. Maximum height 100 ft. A broad-headed, freely branching tree that grows rapidly and produces numerous sprouts from its roots. (Here, repeated mowing eliminates these.) The bark is whitish on younger branches, dark-colored on older parts. The leaves, es-

59. *Quercus phellos*

60. *Populus alba*

66. *Abies homolepis*

pecially early in the season, are white-woolly on their under sides. The flowers are in catkins in spring, the sexes on different trees. The female flowers are followed by cottony seeds. This tree grows freely in any ordinary soil and stands city conditions well, but is not highly regarded for landscape use because of its suckering habit, the tendency of its roots to invade drains, and the untidiness of its seeds. A narrow, erect variety, *Populus alba pyramidalis* (bolleana poplar) is planted freely on parkways, airports, and in other public places near the sea in the New York area. The wood of white poplar is soft, white, and light in weight. It is used for paper pulp, excelsior, building, and fuel. •

61. Abies homolepis. See number 64.

62. Abies cephalonica—GREEK FIR (family *Pinaceae*). Native of Greece. Maximum height 100 ft. One of the most distinct and easily recognized firs, it forms a symmetrical conical specimen with smooth young shoots and rigid, almost spine-tipped leaves that point outwards at almost right angles from all around the stems, but are more numerous from their upper than from their lower sides. The upper leaf surface is green, the lower marked with conspicuous longitudinal white bands. The cones are brownish. Like other firs this kind is most ornamental when comparatively young. Cultural needs and lumber uses as for number 64.

63. Fraxinus americana. See number 45.

64 through 68. Abies homolepis—NIKKO-FIR (family *Pinaceae*). Native of Japan. Maximum height 100 ft. One of the most satisfactory firs for planting in the eastern states, this handsome species has a symmetrical, pyramidal head. Its young shoots are smooth. The leaves (shining green above, green with two longitudinal broad white bands beneath, and slightly notched at their tips) are in rows, the lowermost the longest and spreading horizontally and each succeeding row shorter and more erect, until the uppermost diverge to form a v-shaped trough along the top of the shoot. The cones are purple before they mature. Like other firs, this thrives best in a well-drained but moist soil and where it receives full sun but is sheltered from sweeping winds. Like other firs, too, it is most ornamental during its first 30-40 years; after that it tends to lose lower branches, become thin and straggly, and lose vigor. Its lumber is soft and perishable. •

69. Abies nordmanniana—NORDMANN'S FIR. CAUCASIAN FIR (family *Pinaceae*). Native of Caucasus, Greece, Asia Minor. Maximum height 150 ft. This handsome fir is one of the most desirable for cultivation in the eastern states. It forms a conical specimen, most decorative during its first 30-40 years. Subsequently, it is likely to become straggly and lose lower branches. Its young shoots have short, stiff hairs. Its leaves are crowded and mostly from the upper sides of the shoots. As with Veitch's fir (numbers 49, 79, 85) the leaves are in rows, the lowermost longest and spreading horizontally, those above progressively shorter. Unlike Veitch's fir, except on very weak shoots no v-shaped trough separates the two upper rows of leaves. The leaves are glossy green above and have two white lines beneath. The cones are reddish-brown. Cultural needs and lumber characteristics as for Nikko fir (number 64).

70. Quercus cerris—TURKEY OAK (family *Fagaceae*). Native of southern Europe and Asia Minor. Maximum height 120 ft. Forms a broad pyramidal head when young, at maturity is often irregular in shape. This handsome species should be planted more frequently for shade and ornament. It grows quickly and has rich green foliage retained very late in fall, but dropping without coloring attractively. Its mossy-cupped acorns ripen in their second year. Its winter buds are distinctive because of the slender downy scales that surround them and are longer than they are. Although not hardy much north of New York City it prospers here. A very fine specimen is located near the road through the magnolia collection at The New York Botanical Garden. The wood is not valued as lumber. This species is the source of galls used in tanning and of oak manna or gaz which is used in Iran in the sweetmeat called gazenjubeen.

71. Acer pseudo-platanus. See number 6.

72. Aesculus hippocastanum—HORSECHESTNUT (family *Hippocastanaceae*). Native of the mountains of Greece and Albania. Maximum height about 100 ft. A noble tree with spreading branches, broad rounded head, and opposite leaves each having 5-7 leaflets that diverge like fingers of a hand. Its winter buds are large, brown, and sticky. It is one of the earliest trees to display spring foliage. The white-tinged-red flowers, borne abundantly and conspicuously in erect massive panicles in May, are followed by large prickly fruits, each containing 1-2 lustrous brown nuts. These, although inedible, have a remarkable fascination for small boys who are apt to be troublesome in their efforts to obtain them by throwing sticks and stones at the trees. Because of this, the non-fruiting, double-flowered variety named *flore pleno* is to be preferred for planting in public places. This is the "chestnut" so freely planted in Paris, France. It is also common as a street tree in London and many other European cities. It requires a deep, rich, moderately moist soil. Its wood is soft and weak.

73. Liriodendron tulipifera. See number 13.

74. Abies cephalonica. See number 62.

75. Abies nobilis—NOBLE FIR (family *Pinaceae*). Native of the Pacific Northwest. Maximum height 250 ft. One of the most satisfactory firs for planting in eastern North America. Conical when young, it tends to develop a broad rounded top at maturity. Its young shoots are clothed with fine down. Its leaves are closely set along the sides and top of the branchlets. The upper leaves have their bases flattened along the branchlets, completely hiding them. The cones, among the largest produced by any fir, are 6-10 inches long and stand erect. Its cultural needs are the same as those of *Abies homolepis* (number 64). Its wood is used for interior finishing, moldings, siding, millwork, venetian blinds, ladders, rails, boxes, and for paper pulp.

76. Acer platanoides—NORWAY MAPLE (family *Aceraceae*). Native of Europe and western Asia. Maximum height 100 ft. A favorite street tree and shade tree. Transplants easily, withstands pruning well. Forms a dense, spreading rounded head. In early spring bears conspicuous clusters of yellow-green flowers

followed by twin-winged fruits. When broken, the petioles exude a milky sap, a feature by which it is readily distinguished from the sugar maple which is somewhat similar in contour and foliage characteristics. The leaves of Norway maple do not color attractively in fall. Its wood is white, fairly hard, and close-grained.

77. Fraxinus pennsylvanica — RED ASH (family *Oleaceae*). Native of eastern North America. Maximum height 75 ft. Similar to green ash (number 1) but young branches, petioles, and panicles covered with dense reddish pubescence, and leaflets thinner and usually pubescent beneath. Culture and uses same as for green ash.

78. Abies cephalonica. See number 62.

79. Abies veitchii. See number 49.

80. Fraxinus americana. See number 45.

81. Quercus macrocarpa—BURR OAK, MOSSYCUP OAK (family *Fagaceae*). Maximum height 160 ft. Native of eastern North America. Usually a tall-trunked tree with spreading branches and a massive broad rounded head, but in some natural stands only a shrub. Its corky branches are conspicuous in winter and, like others of the white oak group, the leaves are without bristles tipping their lobes. In fall its foliage turns yellow or brown. Its acorns are large, their cups conspicuously fringed with many slender scales. It grows rather slowly, thrives best on moist fertile soil, but endures drought remarkably well. A good shade tree and used for shelterbelts. ●

82. Pseudotsuga taxifolia — DOUGLAS-FIR (family *Pinaceae*). Native of western America. Maximum height 300 ft. This splendid evergreen, the state tree of Oregon, is one of the most satisfactory coniferous trees to use as an ornamental. It grows rapidly (its hardier variety *glauca*—the Rocky Mountain Douglas-fir—more slowly than the type) and adapts itself surprisingly well to city conditions. It is pyramidal, its main branches horizontal, its secondary ones pendulous. Its young shoots are more or less downy. Its flexible, straight or slightly curved dark green or bluish green leaves are crowded in two opposite ranks or spread in all directions. They are rounded but not notched at their ends and have longitudinal grayish lines beneath. The cones are drooping, small, brown, and bristly. Douglas-fir thrives in any well-drained, moderately fertile soil. It is excellent as a Christmas tree and for shelterbelts. Named after David Douglas, the brilliant British plant collector who discovered it in the Pacific Northwest in 1830, this is one of America's most important and prolific sources of lumber. Its wood is used for building, plywood, piling, railroad ties, cooperage, fencing, flooring, crates and boxes, furniture, boats. ●

83 and 84. Abies homolepis. See number 64.

85. Abies veitchii. See number 49.

86 and 87. Abies firma—MOMI FIR (family *Pinaceae*). Native of Japan. Maximum height 150 ft. A broad pyramidal tree with rigid horizontal branches and dense foliage. The leaves are stiff, in two more or less horizontally spreading groups with a broad V-shaped trough separating them on the upper side of the branchlets. The leaves are green above, faintly marked with whitish bands below, and are distinctly notched at their tips. The grooves between the leaf bases of the young stems are pubescent. Cultural needs and uses of its lumber are the same as for number 49.

88. Abies homolepis. See number 64.

89. Abies firma. See number 86.

90 and 91. Abies nordmanniana. See number 69. ●

92. Liriodendron tulipifera. See number 13.

93. Betula lenta—CHERRY BIRCH, SWEET BIRCH (family *Betulaceae*). Native of eastern North America. Maximum height 75 ft. A fine pyramidal tree that becomes round-topped at maturity. It has glossy reddish bark resembling that of a cherry. The crushed bark of young branches smells and tastes agreeably of wintergreen. The flowers are in catkins in spring, males and females separately. The female catkins are succeeded by small cones, conspicuous after the leaves fall. The foliage turns beautiful yellow in fall. This ornamental tree thrives best in fairly moist soil. It is the source of an oil similar to and with the same uses as oil of wintergreen. Birch beer is obtained by fermenting its sap. Its wood is valued for the same purposes as that of yellow birch (number 57).

94 through 108. Pseudotsuga taxifolia. See number 82.

109 and 110. Ulmus americana—AMERICAN ELM, WHITE ELM (family *Ulmaceae*). Native of eastern and central North America. Maximum height 120 ft. One of the best-loved and best-known native trees and the state tree of Massachusetts. Characteristically it develops a trunk that divides at 10-30 feet above the ground into a number of major, more or less equal limbs which reach upwards and arch gracefully outwards to form a beautiful round-topped, vase-shaped head. Occasionally specimens occur with erect, undivided trunks and sometimes individuals (as number 109) are feathered down their trunks with short, drooping side branches. Elm leaves are boldly veined, have saw-toothed margins, and are unequally lobed at their bases. Neither flowers nor fruits have any ornamental merit. The latter are dry, elliptic, flat, and winged. The foliage turns yellow in fall. The American elm was long favored, and rightly, as one of the finest avenue and shade trees. Especially in New England entire towns and villages depended upon it, and rows of magnificent specimens give character to numerous communities. But this majestic species has fallen upon evil times. The so far uncontrollable Dutch elm disease (that has caused frightful destruction to elms in and around New York City, including The New York Botanical Garden as well as elsewhere) and the elm phloem necrosis disease (that is even more deadly and has been particularly destructive in the Middle West) are so threatening that many gardeners and landscape architects are wisely refraining from planting American elms at least until, if ever, acceptable control for these scourges is discovered. American elm thrives best in rich, fairly moist soil. Its wood is heavy, hard, and tough. It is used for furniture, vehicle parts, dairy, poultry and apiary supplies, boxes, baskets, crates, and barrels.

81. *Quercus macrocarpa*

82. *Pseudotsuga taxifolia*

91. *Abies nordmanniana*

THE BOTANICAL GARDEN AS AN OUTDOOR LABORATORY FOR TAXONOMY

By WILLIAM CAMPBELL STEERE

Dr. Steere is Director of The New York Botanical Garden. This paper, one of four in a symposium entitled "The Botanical Garden as an Outdoor Laboratory for Teaching," was presented on August 30, 1960, before the Teaching Section of the Botanical Society of America at its annual meeting at Oklahoma State University, Stillwater, at the invitation of the Chairman of the Section, Professor Harriette V. Bartoo.

IN THIS SYMPOSIUM to discuss the significance of "The Botanical Garden as an Outdoor Laboratory," I have been asked to speak on the botanical garden as a taxonomic tool. My primary problem is that I take so for granted that a botanical garden *is* a taxonomic tool that I can't imagine a contrary situation—and nothing is more difficult to prove convincingly than the obvious! Serious convictions, of course, are not necessarily based on logic or even on facts, as we see so well demonstrated during the current election year. To be forced by necessity to explore the anatomy of my conviction that a botanical garden is almost by definition a taxonomic tool, and that a so-called botanical garden or arboretum without teaching and research interests is only a park, provides healthy self-discipline for me.

My other serious difficulty in preparing and presenting this paper is the necessity for isolating only one element from as highly complex and diversified an operation as The New York Botanical Garden. We have such live and active interests in all the four areas of this symposium, that we could have provided experienced staff members to give all four papers. However, the chairman showed great wisdom in selecting a panel of participants from four different institutions and thereby bringing an even broader spectrum of experience to this discussion of the complicated, subtle, and sometimes frustrating aims and activities of botanical gardens.

The functions of botanical gardens from earliest times have been several and diverse, ranging from the purely aesthetic to the purely applied. The basic proposition of all botanical gardens, however, is a collection of plants, and so we immediately perceive the need for some sort of systematic arrangement of the plants from which taxonomy naturally develops. It is no accident that the important centers of taxonomic research and teaching grew up around the various great botanical gardens of Europe. The mention of Kew, Berlin-Dahlem, Copenhagen, and many other place-names brings to the mind of educated people the thought of some great botanical garden. To the botanist, these cities also coincide with centers of outstanding taxonomic research.

The early recognition of relationships among plants and the consequent development of the concept of families and orders of plants arose long before the advent of the theory of evolution and our present-day ideas of phylogeny, just from the evidence of observing many kinds of plants growing together in botanical gardens.

The large botanical gardens of the world, then, combine with their recreational and park functions the creative research potential made possible by enormous collections of living plants outdoors and under glass. Financially, The New York Botanical Garden is a sort of double-headed monster that carries on many of its recreational and park activities with the support of funds derived from the City of New York, whereas its educational, research, and publication programs are financed almost entirely with the income from endowment and other funds from private sources. Quite to the contrary, Kew and most other important European botanical gardens are supported completely by their national governments, yet are encouraged financially to carry on their extensive programs of original investigation. The New York Botanical Garden must find support for its research activities by obtaining grants of funds from the National Science Foundation, the National Institutes of Health, the Atomic Energy Commission, the Office of Naval Research, and other federal and private agencies and foundations. Funds for teaching are likewise derived from gifts, grants, tuition, and from sources other than the City of New York.

The official statements of two important botanical gardens with reference to their primary functions are germane to this symposium and especially appropriate to the topic of my assignment. I have chosen the Royal Botanic Gardens, Kew, and The New York Botanical Garden not only because they are well known to everyone, but also because the magnificent facilities at Kew seventy years ago inspired the founding of The New York Botanical Garden.

The *Illustrated Guide to Kew* says: "Kew Gardens, it must be remembered, primarily serves scientific purposes. The Institution has as its main objectives the accurate identification of plants and the provision of information in the field of botany, both pure and applied...."

"By a large proportion of those who come to Kew, it is thought of rather as a place of recreation than as a scientific institution, but valuable as the former service is, it must be appreciated as a by-product of the Institution's main purpose, and therefore the usage of the gardens by the public must not be allowed to hamper its chief functions as a scientific establishment. Fortunately, the proper safeguarding of the living collections and their efficiency is the best guarantee that the public will obtain the maximum enjoyment from them without detriment to botanical science."

In an appreciation of "The scientific work of Nathaniel Lord Britton" (Proceedings, American Philosophical Society 104: 205-226. 1960) Dr. H. A. Gleason points out emphatically how little the purpose of The New York Botanical Garden today has changed from its original intent in the beginning. A small brochure circulated by the Torrey Botanical Club in 1889 states, according to Gleason, "The use of a botanic garden may be reckoned as of four sorts. First and foremost is the purely scientific and educational use. Subsidiary to this, but still of a marked degree of importance, are the pharmaceutical and horticultural

uses, and lastly, the general use as a place of agreeable resort for the public at large." Even though the wording might be somewhat different today, the spirit remains the same—we are fundamentally and primarily a scientific research institution. The resemblance of the basic philosophy of The New York Botanical Garden to that of Kew, in the insistence on the importance of the research function, is not sheer coincidence. As you may know, the first idea of creating a great American botanical garden came to the mind of Dr. Britton and his wife when they visited Kew in 1889. The statement just quoted was undoubtedly written by Dr. Britton and was just as undoubtedly inspired by a parallel and contemporary policy statement at Kew.

The first botanical gardens were collections of plants for useful purposes and for recreation. Collections of medicinal plants several centuries ago led to the production of herbals that described the plants and their uses. The herbals, in turn, led to more accurate descriptions of plants and to the first stirrings of modern taxonomy. The Chelsea Physic Garden in London, like many of its sister institutions, was established for growing medicinal plants and for initiating potential medical practitioners into the mysteries of materia medica—and today it is still used for teaching taxonomy to medical students.

The systematic gardens at Kew and in other European botanical gardens are excellent tools for self-instruction in taxonomy a well as for formal teaching purposes. One sees many visitors in them, both students and adults, busily occupied with taking notes. In my own opinion, the systematic arrangement of plants in some area of a botanical garden is of utmost importance, in spite of disparaging and irreverent remarks about "botanical graveyards," and the admitted tendency of even closely related plants to conflict in size and shape, and for their flower colors to clash.

Browsing through the systematic plantings of the University of Michigan Botanical Garden, while I was still a high school student, gave me an early understanding of plant families that made my university work much easier. Many years later, as a staff member at the University of Michigan, I occasionally taught a course dealing primarily with the identification of the local flora, under the somewhat grandiose title of "Systematic Botany." It was only natural that I chose to use the Botanical Garden as an outdoor teaching laboratory—as a source of material of living plants to be studied individually, and to illustrate family characteristics. Seeing related plants together—and alive—helps students to understand the concept of plant families and other major taxa more easily than any other method I know. Curiously enough, The New York Botanical Garden is one of the few large, research-oriented institutions without an outdoor garden arranged in systematic order. However, plans for remedying this lack of a teaching facility have been made by T. H. Everett, Assistant Director (Horticulture) and Curator of Education, and planting has already been begun by Louis Politi, Horticulturist.

The use of botanical gardens as outdoor laboratories for taxonomy falls into several categories based on the intellectual level and the degree of motivation of the users, as follows:

1. *The casual learning of the names of a few trees or other plants by the inspection of labels in a park, arboretum, or botanical garden.* Any botanical garden, even of the smallest size, can satisfy this "idle curiosity" function, although it should, of course make some attempt to create and to stimulate a real interest. Carefully planned, informative labels are a "must" at this level.

2. *The motivated learning through self-teaching or through organized courses and educational programs of the names of horticultural and native plants by serious amateurs.* This is a more serious responsibility of botanical gardens, which requires very considerable preparation and activity by professional staff members. During the past two summers, The New York Botanical Garden has conducted a Summer Institute in Botany for gifted high school students, in which the students were introduced to the field of taxonomy among other botanical topics.

3. *Formal teaching for credit, at the high school or undergraduate college level, whether for students taking a general program or for those planning to enter the field of botany or some related science.* In any elementary course in botany or biology, the botanical garden is truly an excellent outdoor laboratory for teaching the various types of plants, and their structure and modifications, as related to taxonomy. For more advanced courses that center on taxonomy, the identification of plants, learning the local flora, becoming acquainted with the major plant families, and learning something about the basis of phylogeny, class work in a botanical garden or arboretum is so highly desirable as to be essential.

4. *The professional training of graduate students, either for some background in taxonomy or for actual specialization in this field for advanced degrees, as the master's or doctor's.* This level of teaching and the continuing research in taxonomic problems by staff members place the highest requirements on botanical gardens, and it is in these areas, as already pointed out, that the great botanical gardens of the world function most effectively. I grew up in the immediate vicinity of the University of Michigan Botanical Garden and spent much time there during my formative years. It was no accident, then, that I used its facilities to grow the plants for my own doctoral thesis and eventually became a member of its staff. Seeing this Botanical Garden during its "golden years" between 1925 and 1935 left an indelible impression on me concerning the responsibilities of botanical gardens as teaching and research centers. Professor Harley Bartlett must be given great credit for his vigorous encouragement of graduate-student training by means of collections of living plants, and for attracting other researchers by the facilities of the University of Michigan Botanical Garden, of which he was director. Probably no educational center in the United States could match at that time the diversity or the intensity of the active investigation of the taxonomy, cytotaxonomy, and cytogenetics of living plants collected specifically for such studies. Those were the years of intensive research, for example, on *Oenothera* by H. H. Bartlett, B. M. Davis, Frieda Blanchard, Sterling Emerson, and others; on *Rosa* by Eileen Erlanson; on *Zea mays* by E. G. Anderson and Marcus Rhoades; on *Petunia, Salpiglossis,* and *Solanum* by E. E. Dale; on *Solanum, Nicandra,* and other solanaceous genera by Janaki-Anmal; on *Ambrosia* by K. L. Jones. After the great de-

pression, which reduced the financial support and activities of this botanical garden, the earlier momentum was never regained.

The University of California Botanical Garden likewise based outstanding taxonomic work on collections of living plants. Many doctoral students contributed to the brilliant work on *Crepis* by Babcock and Stebbins and on *Nicotiana* by Goodspeed and his associates. The Arnold Arboretum has long been a center of taxonomy and cytotaxonomy of woody plants, based on the great and relatively complete collections well suited for such investigations. The active program of plant exploration supported by the Arnold Arboretum has made as great an impact on plant taxonomy as on horticulture.

If I had any fault to find with the training of graduate students in taxonomy at The New York Botanical Garden, it would be that they are not encouraged—or required—to bring together living materials of as many as possible of the species of the group upon which their doctoral work centers. Even though plants grown away from their native environment and climate may not necessarily develop in a completely typical manner, they still contribute enormously to an understanding of the taxonomy of any group. Of course, it would be foolish of us to try to furnish a student with mature living examples, side by side, of all the species of some genus of tropical trees; but I would hope that we could make it possible for him to visit one of the great tropical botanical gardens. However, to avoid giving any impression that The New York Botanical Garden has been delinquent in amassing collections of living plants for research in taxonomy and related areas, I shall remind you of the magnificent four-volume monographic treatment of the *Cactaceae* by Britton and Rose, based in large part on living material in the Garden's conservatories. A. B. Stout's important and long-continued work on taxonomy, cytology, and selection in *Hemerocallis* provides another outstanding example of staff research on living plants.

Most of the great botanical gardens of the world, in addition to their collections of living plants, also maintain excellent library facilities and a herbarium of dried reference specimens, representing not only the plants growing in the garden but also plants from all parts of the world. In fact, the four primary facilities of any botanical garden that is actively engaged in research and education in plant sciences are the collections of living plants (both out of doors and under glass), the library, the herbarium, and the laboratory.

Specialized botanical gardens have a more restricted usefulness than large, general gardens, but by their very specialization may be enabled to go farther in their chosen direction than the more diffuse general garden can. The Fairchild Tropical Botanical Garden near Miami, Florida, is an excellent example. The magnificent collection of palms and cycads brought together by Colonel Robert Montgomery, first on his own estate and later at the nearby Fairchild Garden, which he founded, is by far the best taxonomic tool for palm specialists in continental North America. The Santa Barbara Botanic Garden and the Rancho Santa Ana Botanic Garden, with their emphasis on the native plants of California, provide an easily accessible source of research material for the visiting botanist. Many other types of specialized gardens occur in this country, for the collection and demonstration of cacti and other succulents, Bible plants, herbs, medicinal plants, roses, native plants, and so on; each one, in its own way, provides an important taxonomic resource for teaching and research. The many specialized collections of horticultural varieties of crop plants originated and maintained for applied research by various branches of the U. S. Department of Agriculture and by various federal and state agricultural experiment stations likewise provide an important research potential for taxonomic research.

In summary, the effectiveness with which a botanical garden may serve as a taxonomic tool varies in direct proportion with the richness of its collections. A small collection of native plants serves as a useful device by which to teach the local flora to students and to interested lay persons. A more sophisticated collection of plants with a broader geographic scope will lend greater depth and range to the teaching and, of course, to the learning. In order to serve as a research tool, the botanical garden must have both specialized and representative collections that, in addition to all the other responsibilities, may reflect the specific research interests of individual staff members and of graduate students. The number of botanical gardens that have budgets adequate for the support of research collections is unfortunately much too small in every country. However, the increasing contribution to the community by botanical gardens, together with the increasing public interest in gardening, in conservation, in camping, in outdoor recreation, and in photography has brought with it a growing interest in plants, which, with proper nutrition and focus, we hope will lead to better public support of botanical gardens in general.

VIBURNUMS THROUGH THE YEAR

By DONALD R. EGOLF

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THE OLD-FASHIONED snowball, or guelder-rose, and the black-haws of the roadside and thicket are among the commonly known species of the diverse and adaptable genus *Viburnum.* It comprises more than one hundred and seventy-five species in the north temperate zone of both the eastern and western hemispheres. Although the native American species may not equal their Asiatic cousins in flower and fruit, they do include several of the most adaptable forms. The species extensively cultivated are natives of Asia, Europe, or North America. When conditions permit further plant exploration, there will undoubtedly be additional select introductions from other native habitats.

The genus *Viburnum* is a member of the *Caprifoliaceae*, the honey-suckle family, which includes also *Lonicera, Sambucus, Weigela, Kolkwitzia, Abelia,* and *Symphoricarpos. Viburnum* most closely resembles *Sambucus,* the elder, in the flower and the arrangement of flower and fruit. Viburnums are shrubs or small trees, deciduous or evergreen, and have naked or scaly buds, opposite, simple leaves, and small white or pinkish white flowers in cymes or panicles. The fruit is a one-seeded drupe, usually blue, black, or red.

The diploid (2n) chromosome numbers of *Viburnum* range from 16 to 72, forming several polyploid series. These complements are composed of several basic genome groups with the basic numbers (n) of 8, 9, and 10. Most of the species, including those native to the United States, have a basic number of 9 group and have a diploid (2n) chromosome number of 18 or a multiple thereof. The species with 8 and a diploid number of 16 or higher polyploid are restricted to Asia and are characterized by having a panicle such as is found in *V. fragrans* and *V. sieboldii.*

Viburnums are sturdy shrubs which, because of their hardiness and variability, are used extensively in northern landscape plantings for mass or specimen effect.

Most species can be propagated by one or another technique—the taking of cuttings or divisions, grafting, layering, or sowing seeds. Seeds, layering, grafting, and hardwood cuttings were the basic methods of propagation until the advent of interrupted mist propagation; now softwood cuttings have become the major method for asexual propagation. The number of plants desired and the facilities available will determine the propagation procedure adopted by the home gardener. If only a few plants are required and there are no propagation facilities, they can be secured by division of the sucker shoots that often appear near the base of the plant. A vigorous young branch, wounded with a slight cut in the bark near the tip and buried in soil, will strike roots the first season; but it will probably benefit by not being severed from the parent plant and transplanted until the second season.

Grafting is commonly practiced with *V. carlesi*, which is veneer-grafted or shield-budded on the seedling understock of *V. lantana.* Such techniques produce a salable plant in a shorter period of time but do not always please the home gardener. The objection to a grafted plant is the competition that develops between the stock and cion as the plant matures. The keen plantsman may recognize the difference between stock and cion and be on constant vigil with the pruning shears; but the amateur, unaware of understock growth, may realize after a few years that he has a plant of *V. lantana* and not *V. carlesi* or one of the other hybrids. In addition to the competition between stock and cion, there is always the matter of compatibility and differential growth-rate of the two.

Plants are propagated by cuttings or seed if a larger number is required. Six-to-eight-inch hardwood cuttings taken in late fall will be rooted late the following spring. Softwood cuttings made in mid-June through July will be well rooted in three weeks or less, depending on the species. The early-rooted cuttings will be well established by fall and will be less susceptible to winter injury.

Seed germination is complicated by dormancy or by inhibitors of the embryonic root and shoot. A warm pre-treatment of the seed at 20° C (68° F) will induce root development. If, after a prescribed time lapse, the seed is exposed to 5° C (41° F), the epicotyl, or shoot, will develop. Sowing seed in outdoor beds or pots in early summer and allowing them to freeze the following winter will simulate the warm period followed by a cold period that initiates germination. If the seed cannot be sown until late summer the length of the warm pre-treatment may be insufficient, and germination will not be achieved until after the second exposure, that is, after the second winter. Since viburnums will not come true from seed, and many inferior plants may be grown for each good one, it is recommended that propagation be carried on asexually by cuttings, layering, or grafting.

The majority of the species are not fastidious about soil but thrive somewhat better on heavy loam with a pH of 6.0 to 6.5. There are, however, the exceptions, such as *V. acerifolium, V. furcatum*, and *V. lantanoides*, that prefer a moist, organic soil with a more acid reaction in the range of pH 4.5 to 5.0. *V. cassinoides, V. dentatum, V. lentago,* and *V. scabrellum* are well adapted to moist areas, whereas *V. acerifolium, V. lantana, V. opulus, V. prunifolium,* and *V. rafinesquianum* are adaptable to both shady and dry conditions. Many species will benefit by partial shade; but, in general, the fruiting forms will produce best if they are in full sun for most of the day.

Once they are properly established, the viburnums demand little maintenance, as they are practically free from insects and diseases. If sulphur or sprays containing sulfur should come in contact with the foliage, it will cause rapid defoliation. Many recognize *V. opulus* and its cultivars by the distorted leaves and branchlets that have resulted from extensive aphid infestations. Sprays of lindane or mala-

The pale pink flowers of *Viburnum fragrans* are borne at the ends of spurs.

thion before the leaves have curled will readily control aphids. Mildew, which may be troublesome in late summer, can be controlled with a karathane spray. Bacterial leaf-spot is seldom prevalent enough to disfigure the foliage on susceptible members of the Lantana group. A Bordeaux mixture or some ready-made copper fungicide will prevent the spread of this disease.

On a bleak winter day the pendulous red fruit of *V. trilobum,* the American cranberry-bush, or of *V. opulus,* the European cranberry-bush, is a welcome sight in the garden mounded with snow. This fruit is not readily eaten by birds and will remain on the plant until late winter. Other species such as *V. prunifolium*, blackhaw: *V. lentago*, nannyberry: *V. acerifolium,* maple-leaved viburnum: and *V. dilatatum*, linden viburnum, provide a winter source of food for wildlife and will encourage birds to remain nearby to enliven the winter scene. Of course, the winter fruit cannot rival that of the autumn in its brilliant display, but what other shrub can be so admired in midwinter?

The deciduous viburnums form a diverse structural frame-work for the winter landscape. The habit of growth largely determines how useful a plant is for twelve months in the landscape rather than for only a few months in summer or fall when in flower or fruit. The landscape architect may choose from an array of growth-habit forms such as the picturesque, gnarled branches and trunk of *V. sieboldii;* the horizontally tiered branches of *V. plicatum tomentosum,* and *V. prunifolium*; the globose medium shrub of *V. carlesi or V. dilatatum*; or the dwarf cushion-form of *V. opulus nanum* or *V. fragrans nanum.* Viburnums have many characteristics that make them desirable for use as specimens, as trimmed or informal hedges, as mass plantings or as small trees.

The few evergreen species hardy in northern areas may provide accent in winter. Unless *V. rhytidophyllum* (6)*, the leather-leaf viburnum, is in a well-protected location, the windswept foliage may droop sadly on cold days, and even fall from the plant; but in a sheltered situation the eight-inch-long, deeply rugose leaves on a well-grown eight-to-twelve-foot plant can be a feature of the garden throughout the year. The cream-white flowers are showy for only a few days in early May. In late summer the green fruit provides a striking contrast as it matures and changes from red to black. The plant will be semi-evergreen as far north as Boston. The cultivar *V. rhytidophyllum roseum* will display the pink color only in the buds. The hybrid *V.* × *rhytidophylloides* 'Willow Wood' (6), *V. rhytidophyllum* × *V. lantana,* is somewhat hardier but will defoliate much earlier in the season. This wide-spreading plant may attain a height of fifteen feet. The semi-evergreen *V. buddleifolium* (6) has eight-inch-long, pale green, soft, velvety-textured leaves. This plant from central China will thrive in areas south of Philadelphia, but in more northern areas it will often be killed to the ground by low temperatures. The evergreen *V. utile* (6), one of the parents of the well-known *V.* × *burkwoodi* (5b), is a graceful, fine-textured, compact shrub which rarely grows more than five feet high. The small, glossy, green leaves are densely yellow-gray-pubescent beneath, as are the naked winter buds and the young branchlets. In late April the fragrant white flowers are very similar to those of *V. carlesi*, but slightly less fragrant. This choice Chinese species was introduced by Wilson in 1901; it deserves more extensive cultivation.

Few other evergreen species can endure the winters of the Northeast. In a sheltered patio corner, *V. tinus* (7b), the laurustinus, *V. odoratissimum* (8), *V. japonicum* (7), or *V. davidii* (7b) may thrive. Even in protected areas along the East Coast, one can expect these species to be somewhat injured during severe weather. *V. tinus*, the laurustinus, is a large globose shrub of twelve feet or more in its native habitat in southern Europe and northern Africa, but in the Northeast it will seldom be more than four feet high. The white blooms of late fall, winter, and early spring appear after a few warm days. The interesting but not effective metallic-blue fruits remain on the plant for an extended period. The large, ovate, glossy, green leaves and abundant red fruit clusters of *V. japonicum* combine to provide a

This is a mature, free-flowering specimen of *Viburnum rhytidophyllum.*

first-rate plant. The heavy-textured, lustrous dark green, six-to-eight-inch leaves of *V. odoratissimum* are borne on a plant which in a mild climate or protected location may obtain a height of ten feet. This plant will seldom flower or fruit, but it is worthy of cultivation for its handsome foliage. The panicles of fragrant white flowers are followed by brilliant red fruits which turn black. Of all the evergreens, *V. davidii*, David's viburnum is one of the choicest; it has many meritorious characteristics. The leathery, dark green, six-inch, three-veined leaves make this low plant useful for foreground planting and for planters. The white flowers in early spring are not outstanding but add to the merit of the plant. The briliant metallic-blue fruits persist on the plant for much of the year but are not conspicuous. This species was discovered by Abbé Armand David in Mapin in Western Szechuan, China, and was introduced into cultivation by Wilson in 1904.

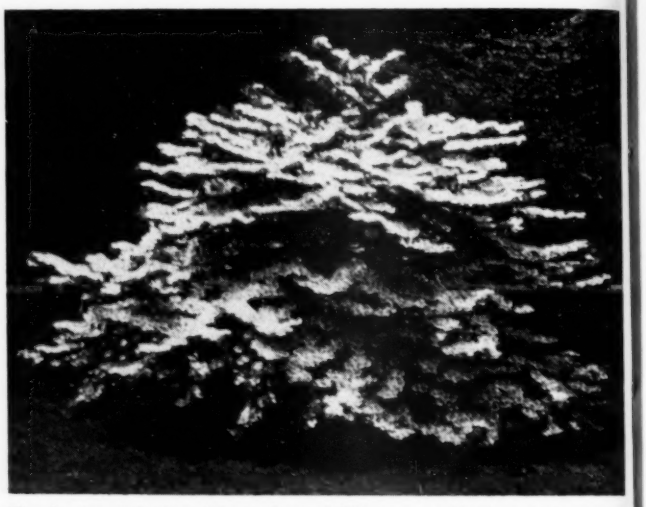
The appearance of the pale pink, sweetly scented flowers of *V. fragrans* (5b) in late March or early April is a sign that spring is arriving. The plant may flower sparsely on twiggy growth, but since it appears before *Forsythia* and *Cornus mas*, it is highly esteemed. A ten-foot specimen with arched branches is handsome in flower or foliage. Reginald Farrer, who introduced this plant from Kansu, China, gives an exuberant account of his first encounter with it in his book *On the Eaves of the World*. The white-flowered form, *V. fragrans alba* (5b), has slightly larger flowers but these tend to be more susceptible to injury by freezing. The dwarf compact *V. fragrans nanum* will seldom exceed two feet in height and is a choice foreground or low hedge plant. Young plants usually flower sparsely. The fruits, secluded by the dense foliage, mature in early summer and are readily eaten by the birds. Although the variety is hardy in northern areas, the flower buds may be winter-injured and then few flowers appear the following spring, or those that open early will turn brown. The plant is flower-bud-hardy in southern New York if planted in a sheltered, sunny location. This is one of the most neglected viburnums and one that should be more extensively cultivated.

V. grandiflorum (6), a native of the Himalayas, is unknown in cultivation in the Northeast. The larger, deep rose flowers will not endure so much frost as *V. fragrans* (5b). A mature *V. grandiflorum* plant may be ten feet high and a compact, globose specimen, but young plants tend to be leggy and sparse-flowering. This plant has been hybridized with *V. fragrans* to produce the hybrid *V.* × *bodnantense*. The inflorescence, foliage, and growth-habit are intermediate between those of the parents; however, the hybrid is hardier than *V. grandiflorum*.

V. foetens (7) can be grown south of Philadelphia, but the waxy white flowers of late winter and early spring may be disfigured by freezing. The leaves have a pungent odor when crushed or decaying, which is also characteristic of several other members of the genus. This five-foot plant is much admired for its early bloom, but will not thrive unless it is in a protected corner.

With the advance of spring the species with cymes of tubular white or pink florets highlight the landscape. *V. carlesi* (5), the fragrant or Korean spice viburnum, is a five-foot plant known to many. In late April the clusters of pink buds change to white as the flowers open; they resemble those of trailing arbutus in both shape and fragrance. A semi-shady situation is necessary for maximum growth and flower. *V. carlesi compacta* (5b) is a recently introduced dwarf form that should be more suitable for the small garden. A number of species and hybrids have an inflorescence similar to that of *V. carlesi*. *V.* × *burkwoodi*, a hybrid of *V. carlesi* × *V. utile*, has glossy, semi-persistent foliage. *V. chenaulti* (5) is a similar hybrid, but has smaller leaves of a finer texture. The open, thinly branched *V. bitchiuense* (6) produces sweetly fragrant flowers in early May; a mature specimen may be as much as ten feet tall. The cross of *V. bitchiuense* and *V. carlesi* yielded *V. juddi* (6), which is intermediate between the parents in size of inflorescence. The habit of growth more closely resembles that of *V. bitchiuense*. The English introduction, *V.* × *carlcephalum* (5b), is relatively new in this country; it has proved a noteworthy ornamental. *V. carlesi* was crossed with *V. macrocephalum* (7) to produce the hybrid of robust, somewhat coarse habit of growth. The large clusters of clove-scented, white flowers lack the refinement and quality of *V. carlesi*.

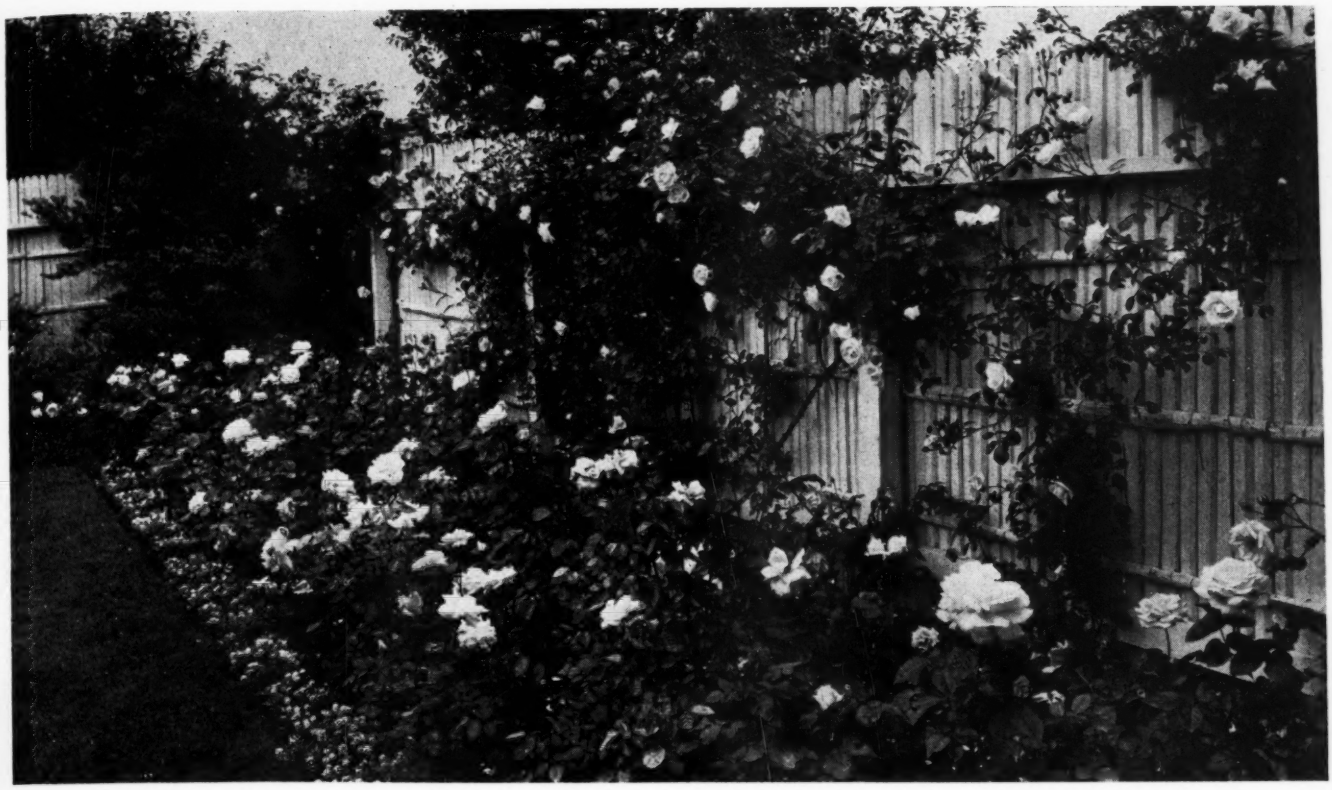
The hobblebush *(V. alnifolium)* (4), which inhabits the moist, acid woodlands of the Northeast, is one of the spectacular species in flower. The large inflorescence is composed of fertile florets encircled by a marginal ring of enlarged sterile florets and creates a Queen-Anne's-lace pattern in the late April woodland. Unfortunately, this choice native is difficult to cultivate unless the soil conditions approximate those of its native habitat. The six-inch, orbicular, deeply rugose leaves are ornamental throughout the season, but they are especially outstanding when red in the autumn. The name hobblebush is derived from the tangle of stems (which develop from underground shoots or by layering of the branches) that trips the traveler or causes him to hobble.



The horizontal, tiered branches of *Viburnum plicatum tomentosum* are accentuated by abundant flowers.

(To be continued)

*The number after the species in the text refers to the hardiness zone according to *Plant Hardiness Zone Map*, U. S. Dep. Agr. Misc. Publ. 814. The suffix b with the hardiness zone indicates that the plant is hardy only in the warmer parts of the zone.



Hybrid Teas in a bed edged with sweet alyssum and climbers on the wooden fence that encloses this informal rose garden.

LANDSCAPING WITH ROSES

By MARY H. STOCK

Miss Stock majored in design at the School for Horticulture for Women, at Ambler, Pennsylvania, now Ambler Junior College, a division of Temple University. After working for a year in her father's nursery in Bethesda, Maryland, she attended the University of Georgia from which she received B.S. degree in landscape architecture in June 1958. Since then Miss Stock has been developing a landscape practice from her home in Rockville, Maryland.

ONE OF THE FIRST pictures that often comes to my mind in thinking of a rose garden is a formal garden unit of a large property or estate. Can you recall such a garden from your experience? One of the loveliest series of gardens I have seen is the Old Westbury Gardens on Long Island, New York. The English architect George Crawley designed the eighteenth-century house and associated formal gardens to blend with the countryside.* The series of gardens includes a rose garden through which one walks under a brown wooden trellis with pink roses climbing overhead and the blue sky filtering through.

We are fortunate in maintaining outstanding older gardens of this country where inspiration can be gained to create today's gardens. The principles of design remain the same whether applied to our public and institutional buildings or to our own backyards.

In the effective use of roses or any other plant in the landscape, people have drawn on a few age-old design principles, principles which apply in many other creative fields. These principles relate to unity, scale, color, form, line, texture, and balance. The principles are applied in varying measure by architects, interior designers and decorators, dress designers, and others.

Let us take a practical example: suppose you have moved into a new house. You have decided to extend your living space, but you want privacy from neighbors, a terrace for outdoor entertaining, a beautiful view from the picture window, roses, and many other things. This requires organization—organization in relation to your needs, in relation to your budget, in relation to the physical aspects of your property, and, to an extent, in relation to conditions on adjacent properties. The first principle is *unity*. To reflect this unity the rose bed should be in some way related to the terrace, to other plantings, or to the house.

The second principle relates to *scale*. Scale is a size and quantity relationship which exists among people and the things and areas they use. For example, public parks and municipal rose gardens are generally designed on a large scale with large rose beds and wide walks to accommodate many people without crowding. A garden in a residential development serves a smaller, more intimate group. The garden reflects the habits and characteristics of the owners for whom it is designed. Even if on some lots it is im-

*See information pamphlet, Westbury House, published by Old Westbury Gardens, P.O. Box 265, Westbury, Long Island.

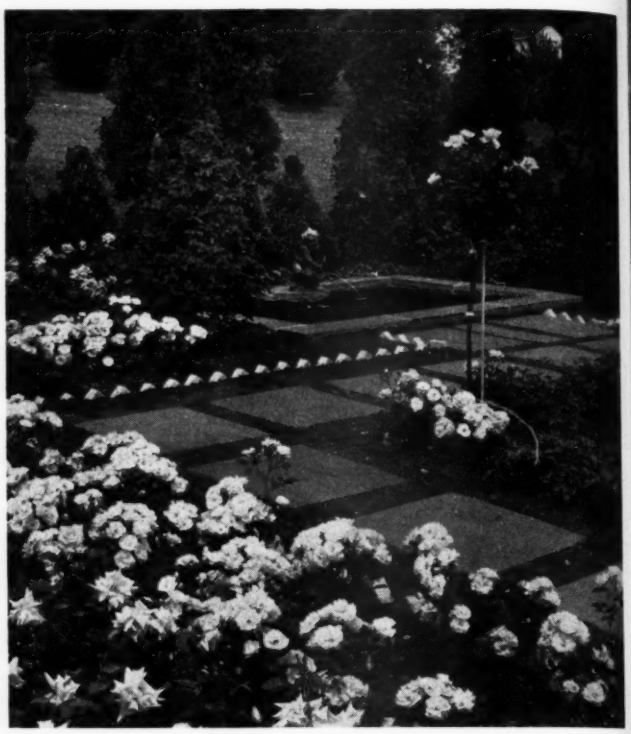
possible to achieve the space actually necessary for many activities, it is possible to achieve space visually. Their gardens reflect a different culture from ours and a populous country, but the outstanding artists in visual scale are, in my opinion, the Japanese. As you read ahead, you will find that scale can be influenced by the use of color, form, line, and texture.

A third design principle relates to *color* and its use. Dark colors shaded grey recede, while bright colors and white come forward. Anyone who has ever been south to Florida in late winter, then returned north to Washington, D. C., or a northern state to see the delicate hues of early spring is more than usually appreciative of seasonal change and color. However, light, reflection, and shadow are also involved in this third principle. For example, in the South, along the coast of southern Georgia, the wide open marshlands are dramatized when contrasted with the deep shade of live oaks hung with Spanish moss.

Color and light also relate to stone work and buildings. Let us suppose someone wants to plant a climbing rose against a stone house. What color should he choose? In a house in which the stone is predominantly gray, there may also be stone with a purple or yellow cast. If the stone has a purple cast, a yellow floribunda climber such as 'Goldilocks' could be used for contrast, as yellow and purple are complements. If there is yellow in the stonework, an analagous color combination could be worked out—perhaps a two-toned climbing Hybrid Tea such as 'Peace' would be planted. The same approach would be used when planting against brick.

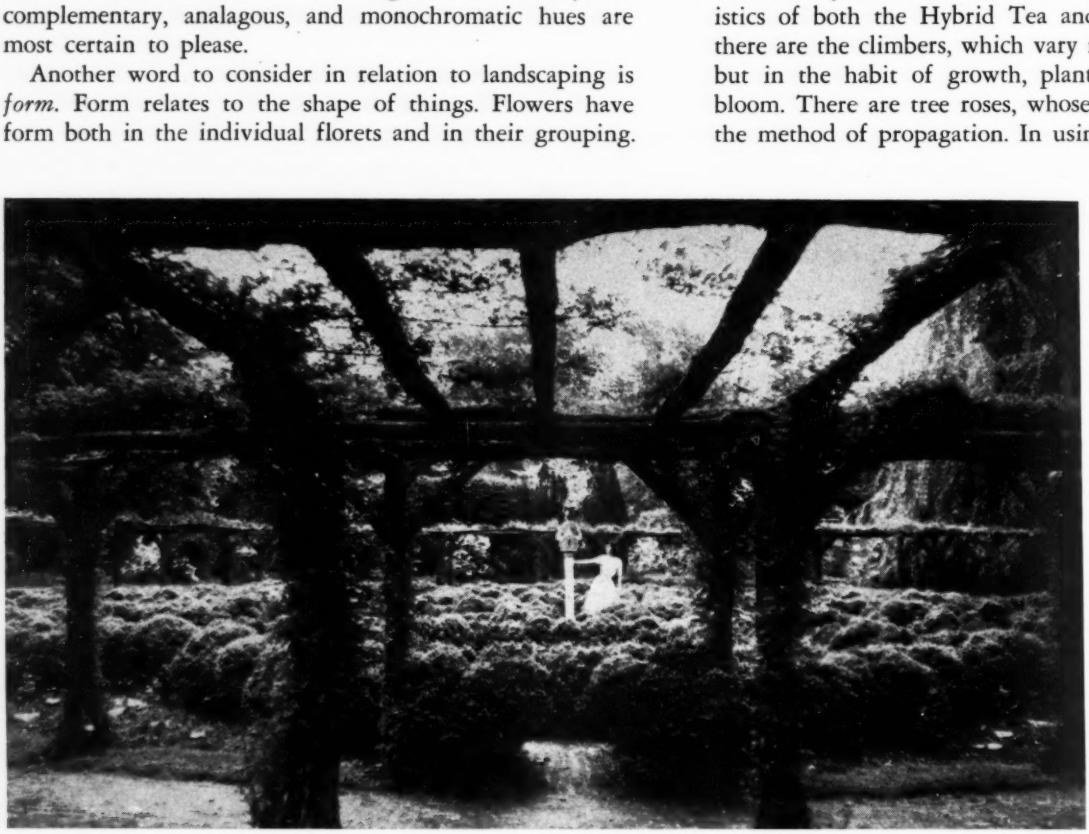
Bricks are toned orange, purple, and red with varying tints and shades. Although there are exceptions, where difficult-to-combine colors are used together successfully, the complementary, analagous, and monochromatic hues are most certain to please.

Another word to consider in relation to landscaping is *form.* Form relates to the shape of things. Flowers have form both in the individual florets and in their grouping.



This formal rose garden has a small pool and charming statue as focal points and an effective evergreen background.

The flowers of roses, as those who grow and enjoy them know, vary in form individually and according to type. Buds of Hybrid Teas generally are longer and grow singly, while Floribundas do not have such long buds and grow in clusters. As a group the Floribundas tend to be lower-growing than the Hybrid Teas. The Grandifloras combine characteristics of both the Hybrid Tea and the Floribunda. Then there are the climbers, which vary not only in flower form but in the habit of growth, plant form, and amount of bloom. There are tree roses, whose form is determined by the method of propagation. In using plant and rose forms



Boxwood and an octagonal English sundial are features of the sunken rose garden in Old Westbury Gardens on Long Island.

effectively in the landscape, we think first of the form desired, then whether it can be achieved by a single plant or a mass of plants. If a single climbing plant is desired, it could be a climbing rose. If a mass effect is desired, roses could be chosen to achieve it. Floribundas and Hybrid Teas can be used to face down a wall or fence. They can be used as foreground planting in front of taller evergreens, if environmental conditions are good. If the evergreen planting is too tall and casts shadow or if it competes too much for soil nutrients, an evergreen background might still be achieved by having a wide walk or lawn area between the rose bed and the background planting. In these cases the height of the fence, wall, or evergreen planting is decreased visually. When you are landscaping with roses, try thinking first of the form of the planting and then of the roses that can be used to achieve it.

A fifth word to consider in relation to landscaping is *line*. Line is movement. It is caused by a change in material or texture, a change in form, or a change in light and dark or color.

Texture is the way an object "feels." It can be sensed visually. Some materials such as concrete can be given different textures. Plant textures may be described as fine, medium, or coarse, depending on the size and placement of the leaves and their relative smoothness. Relative degrees of fineness and coarseness tend to vary, depending on the materials combined. Roses generally are medium- or fine-textured. Because roses are deciduous, they are used to give variety and interest. Remembering their form and shape, you may use shrub roses as you would deciduous shrubs. Roses can be used as background for lower-growing coarser evergreens to create distance.

Lastly, a garden must have *balance*. There are symmetrical and asymmetrical balances. The formal boxwood-edged rose garden with paths, sundial, and bench is usually and basically symmetrical. However, asymmetrical elements are often introduced as a foil to the symmetrical. For instance, an existing tree may be incorporated in the garden plan. A tree or garden house quite frequently gives vertical balance to an area planted in low-growing plants. The relationship that the tree and planted area bear is also one of scale and form.

Balance also relates to color. For example, a small amount of bright red has more balancing strength than a larger area of pale pink.

If an attempt were made to rate roses in comparison with other plants in terms of these design principles, they would undoubtedly rate best in color. Even, if a rose were chosen for its ability to affect scale, for its plant form, or for its contribution to the design in some other way, its high rating for color would still most likely determine its selection. Generally speaking, roses bloom most dramatically in early summer, with scattered blooms through the summer; then in the fall there is another colorful display. Their colors range through white, pink, red, bi-color, orange, and yellow. Although some varieties clash, others can be grouped harmoniously in the same bed. Some combinations that I like are: 'Mohave', 'Sutter's Gold', and 'Eclipse': and a bed of the pink Grandiflora 'Queen Elizabeth', with a stretch of lawn behind and dogwood; this is especially lovely when the dogwood is in autumn foliage. I like the purple *Clematis jackmanii* near red roses such as 'Chrysler Imperial' or 'Nocturn.' Roses can be incorporated in a perennial bed for color accent, and tree roses can be used in a perennial bed for accent achieved through form as well as color.

In existing gardens, either in actuality or in picture, and in the natural landscape, you can observe unity; you can appreciate scale; and you can see color, form, line, texture, and balance. Then perhaps you will be better able to incorporate these elements into your own landscaping efforts, or at least recognize the lack of existence of good design.

NEW LIBRARY FACILITIES

Under the leadership of Mrs. Hermann G. Place, and thanks to the personal generosity of its members and other friends, and to substantial grants of funds from the National Science Foundation, the Avalon Foundation, The Rockefeller Brothers Fund, and the James Foundation, The New York Botanical Garden had in hand on July 1, 1960, pledges of more than half a million dollars toward the cost of constructing new library facilities. Newbold Morris, in his first months as Commissioner of Parks, made a strong and successful request to the Board of Estimate for matching funds, so that in *The City Record* for January 3, 1961, containing the 1961 New York City Capital Budget, one finds the budget item of $585,030, to be matched by $552,000 in private funds. Our new library, to take the form of a wing attached to the present Museum and Administration Building, should be under construction during the second half of the present year. To all who have helped bring this dream to reality go our appreciation and gratitude.

APPOINTMENT OF ASSISTANT DIRECTOR (Botany)

Dr. Pierre Dansereau, Dean of the Faculty of Science and Director of the Botanical Institute of the University of Montreal since 1955, will become Assistant Director (Botany) of The New York Botanical Garden on April 1, 1961. His appointment was announced on February 20, 1961, by Charles B. Harding, President of The New York Botanical Garden.

Dr. Dansereau pursued graduate studies in botany and agriculture in France and engaged in taxonomic and cytological research on the genus *Cistus* at the University of Geneva, Switzerland, at the Royal Botanical Gardens in Kent, Surrey, England, at the Botanical Museum and Garden in Berlin, Germany, and at the Botanical Institute of Florence, Italy. In recent years he has engaged in ecological investigations in Brazil, New Zealand, Australia, Spain, Portugal, and other countries.

An internationally distinguished botanist, Dr. Dansereau has been accorded many honors and awards in his own country and abroad.

In the March-April, 1958, issue of *The Garden Journal*, Dr. Murray F. Buell of Rutgers University, in reviewing Dr. Dansereau's book, *Biogeography. An Ecological Perspective*, described him as "America's most cosmopolitan plant ecologist."

NEW CURATORIAL TITLE

At its regular meeting on February 20, 1961, the Executive Committee of the Board of Managers of The New York Botanical Garden established a new curatorial title, The Nathaniel Lord Britton Distinguished Senior Curatorship, in honor of the first director of the Garden, to be financed in part from a recent bequest from the estate of Richard Britton, a brother. Dr. Bassett Maguire has been chosen as the first recipient of this honor.

BRIEF NOTES ON RECENT BOOKS

By Elizabeth C. Hall

Miss Hall is Sarah Gildersleeve Fife Research Librarian of The New York Botanical Garden.

General Gardening And Landscape Design

THE BEDFORD GARDENER'S ALMANAC FOR WESTCHESTER AND NEARBY COUNTIES. The Bedford Garden Club. 133 pages, illustrated, bibliography. The Bedford Garden Club, Bedford, N. Y. 1960. $2.75

"Advice for Beginners and Reminders for the Experienced" runs the sub-title of this compact, attractive thesaurus of gardening information, gleaned from books, lectures and articles of the Club's members over the past fifty years. A perfect guide for those gardening within a fifty-mile radius of New York City.

THE GARDENER'S ALMANAC; TIMELY HINTS FOR TIMELY GARDENERS. Farrington, Edward I. 144 pages, illustrated, indexed. Massachusetts Horticultural Society, Boston, Mass. 1960. $1.00

Sections for gardeners in the South and on the West Coast have been added to this welcome twelfth edition of an old favorite, which originated way back in 1939. It has been ably edited by George Taloumis.

GARDENS IN WINTER. Lawrence, Elizabeth. 218 pages, illustrated, bibliography, indexed. Harper and Bros., New York, N. Y. 1961. $4.50

Although Miss Lawrence writes from her garden in Charlotte, North Carolina, her delightful book contains "winter garden" reports from her many gardening friends in New England, Ohio, the West Coast, the South, and other points of the compass. Elizabeth Lawrence is one of our finest writers of garden books; her style and knowledge of plants are not unlike those of the late Louise Beebe Wilder.

STUDIES IN LANDSCAPE DESIGN. Jellicoe, G. A. 112 pages, illustrated, indexed. Oxford University Press, New York, N. Y. 1960. $4.00

Seven chapters based on lectures given by the author in Europe and America. The first two are historical, the next two deal with the influence of the ancient forces on the contemporary landscape, and the last three are concerned with landscape objectives and problems, specifically in England. Mr. Jellicoe is one of Britain's most eminent landscape architects.

SUNSET GARDEN AND PATIO BUILDING BOOK. 174, 96, 96, 96, 112 pages, illustrated. Lane Publishing Co., Menlo Park, Cal. 1960. $6.95

Five complete Sunset books in one volume: *Patio Book; Garden Work Centers; How to Build Patio Roofs; Walls, Walks,* and *Patio Floors; How to Build Fences and Gates.* Generously illustrated with photographs, construction plans, and diagrams. A most useful "do-it-yourself" encyclopedia.

TAYLOR'S ENCYCLOPEDIA OF GARDENING: HORTICULTURE AND LANDSCAPE DESIGN. Taylor, Norman, ed. 4th ed., 1329 pages, illustrated, part colored. Houghton, Mifflin Co., Boston, Mass. 1961. $15.00

The past splendid reputation of this encyclopedia serves as a strong endorsement. Its comprehensive fourth edition, updated, enlarged, and completely revised, includes new plants, new methods, revised nomenclature, forty-eight pages of fine color illustrations and over five hundred drawings in black-and-white. An authoritative, non-technical reference work in one volume for the layman gardener.

THERAPY THROUGH HORTICULTURE. Watson, Donald P. and Alice W. Burlingame. 134 pages, illustrated, bibliography, indexed. The Macmillan Co., New York, N. Y. 1960. $4.95

Horticultural therapy is no longer in the experimental stages. In a relatively short time it has attained professional status and now plays an important role in hospitals and convalescent homes throughout the country. Dr. Watson and Mrs. Burlingame have made a real contribution in presenting this authoritative manual, a storehouse of detailed information and advice on this important subject.

Garden Plants

AFRICAN VIOLET VARIETY LIST. Rector, Carolyn K. 113 pages. Whitlow's Book Store, San Pedro, Cal. 1960. $2.50

"Contains all the registered varieties which have been published previous to January 1st, 1960. Many of the older unregistered varieties have been omitted." A stupendous compilation of over six thousand entries with data as to color, leaf type, size of plant, type of flower, name of hybridizer (when known).

ALL ABOUT BEGONIAS. Brilmayer, Bernice. 223 pages, illustrated, part colored, bibliography, indexed. Doubleday and Co., Garden City, N. Y. 1960. $4.95

For amateurs by an amateur begonia hobbyist who states in her introduction: *"All About Begonias* makes no scientific pretense. Precise botanical terms, classifications and history are bypassed in favor of the language of the amateur." For the home grower of begonias this will be a helpful text. The list of commercial sources of seeds and plants is excellent.

THE BEST OF REDOUTÉS ROSES. Mannering Eva. xvi pages, 29 colored plates. Viking Press, New York, N. Y. 1959. $10.00

A selection from the famous folio work *'Les Roses'* that was published in the years 1817 to 1824. Redouté painted from the living roses in the Empress Josephine's gardens at Malmaison. There are brief descriptive notes in French.

THE BIBLE HERB BOOK. O'Brien, Marian M. 111 pages, illustrated, indexed. Bethany Press, St. Louis, Mo. 1960. paper: $1.95; cloth: $2.95

The food editor of the St. Louis Globe-Democrat gives brief cultural notes on the growing of herbs, but the greater part of her little book is given over to their various uses. She limits her selection of herbs to those mentioned in the Bible and frequently adds an appropriate quotation from the Bible. In addition to tempting food recipes, she gives instructions for making tisanes, pomanders, tussie mussies, potpourri, sachets, and herbal baths and rubs.

CAMELLIA, ITS APPRECIATION AND ARTISTIC ARRANGEMENT. Adachi, Choka. Translated from the Japanese by Hamae Okamoto and Davis Barrager. 278 pages, illustrated, part colored, bibliography. Perkins Oriental Books, Los Angeles, Cal. 1960. $25.00

In the introduction, the late Ralph S. Peer, internationally known camellia connoisseur, has written: "Throughout the book, one is struck by the fact that this is not simply a collection of fine photographs in color—it is an effort to express the Purity and Nobility of the Camellia." The Japanese author of this beautiful volume modestly states that he is neither a scholar nor a gardener, yet he has given the reader wonderful glimpses of the camellia in literature, art, history, legend, and economic uses. He devotes a section to illustrations of the culture of dwarfed "Higo-Camellia" and over one hundred pages of text and plates to the art of Japanese flower arrangement.

THE CARE AND CULTIVATION OF INDOOR PLANTS. Stevenson, Violet. 159 pages, illustrated. Philosophical Library, New York, N.Y. 1959. $4.75

Miss Stevenson, popular English author and lecturer, restricts her scope to plants that can be grown indoors under "normal living conditions." A very readable text with a helpful "Plant Treatment Chart."

CHRYSANTHEMUMS. Thistlethwaite, Edward T. 168 pages, illustrated, indexed. Penguin Books, Baltimore, Md. 1960. $1.45

A Penguin Handbook by a former secretary of the National Chrysanthemum Society [of Great Britain]. "Based on practical experience and on the knowledge of the troubles of others."

FLOWERS IN COLOR. Schwarzenbach, Hans. unpaged, 60 colored plates, indexed. Viking Press, New York, N. Y. 1960. $20.00

A companion folio volume to *Decorative Trees and Shrubs*, published in the early part of 1960. The original French text was written by W. Rytz and translated and adapted by Herbert L. Edlin. Sixty lithographic plates of native flora of Europe and America, arranged by plant family, and accompanied by an interesting, non-technical text. A beautiful gift book.

GETTING STARTED WITH RHODODENDRONS AND AZALEAS. Clarke, J. Harold. 268 pages, illustrated, colored front., bibliography, indexed. Doubleday and Co., Garden City, N. Y. 1960. $4.95

A compact little volume with an abundance of easily assimilated cultural advice, recommended varieties for special conditions, and excellent chapter on history and hybridizing.

HERBS: HOW TO GROW THEM AND HOW TO USE THEM; 6th ed. Webster, Helen Noyes. 204 pages, illustrated, indexed. Charles T. Branford Co., Newton Centre, Mass. 1959. $3.50

A tried and true favorite by a former president of The Herb Society of America; in this new edition a chapter has been added on Biblical herbs.

MAMMILLARIA. Marsden, C. 407 pages, illustrated, part colored, indexed. (Cacticulture Series Book II) St. Martin's Press, New York, N. Y. 1960. $7.75

An important title from England for cactus specialists. Over two hundred and fifty species are described and discussed. Sir Oliver Leese, in the foreword, writes: "Mr. Marsden is to be congratulated on the immense amount of valuable and accurate information he has provided."

RHODODENDRONS AND AZALEAS; THEIR ORIGINS, CULTIVATION AND DEVELOPMENT; 2nd ed. Bowers, Clement G. 525 pages, illustrated, part colored, bibliography, indexed. The Macmillan Co., New York, N. Y. 1960. $25.00

A most complete and definitive work on rhododendrons and azaleas. Since the first edition appeared in 1936, great advances have been made in the knowledge of these plants; in this revised edition Dr. Bowers has recorded the findings and opinions of many specialists as well as given us the benefit of his own observations and research.

TREASURES OF THE GARDEN. Huxley, Anthony J. 95 pages, illustrated, part colored. Hanover House, Garden City, N. Y. 1959. $4.95

A charming collection of flower photographs, many of which depict parts of the flower under high magnification. An animated text gives spicy bits of floral history. Translated and adapted from *'Belles Fleurs de Nos Jardins.'*

Plant Diseases

PLANT DISEASE HANDBOOK; 2nd ed. Westcott, Cynthia. 825 pages, illustrated, bibliography, glossary, indexed. D. Van Nostrand Co., Princeton, N. J. 1960. $13.50

"The Plant Doctor" has done it again, which means that she has produced another excellent, comprehensive work. In this completely revised and updated edition she has described more than two thousand plant diseases and has included the recent findings on nematodes and virus diseases with up-to-date information on garden chemicals. It has been ten years since the first edition appeared. For amateur and professional this is a "must" for the reference shelf.

Regional Books

THE ADIRONDACKS: AMERICAN PLAYGROUND. Sleicher, Charles A. 287 pages, illustrated, bibliography, indexed. Exposition Press, New York, N. Y. 1960. $3.00

The author who has summered in the Adirondack country for many years is an ardent enthusiast of that part of New York State. He has written a delightfully chatty chronicle of the history, people, geography, geology, and fauna of the region, but unfortunately, he devotes only six pages to the trees with hardly any mention of the native flowers.

BIRTH OF A NATIONAL PARK IN THE GREAT SMOKY MOUNTAINS. Campbell, Carlos C. 155 pages, illustrated, indexed. University of Tenn. Press, Knoxville, Tenn. 1960. $5.00

A documented account of the long struggle against political bias, apathy, and selfishness which resulted in the creation of one of our finest national parks, situated in the high mountains bordering North Carolina and Tennessee. Mr. Campbell was in the midst of this controversy. For more than twenty years he has served as secretary to the Great Smoky Mountains Conservation Association, the organization that "inspired" the project.

DOORYARD SUPERMARKET IN THE TROPICS AND SUBTROPICS; ITS DEVELOPMENT AND INSTRUCTIONS FOR FABRICATION AND USE OF ITS PRODUCTS. Perry, Ann M. 433 pages, illustrated, bibliography. Tropical Works, Fort Lauderdale, Fla. 1960. $7.50

A manual for amateur gardening newcomers to the tropics and subtropics by a newspaper columnist who has authored numerous articles on gardening in the lower South. Within the covers of this book is considerable information on growing and using ornamental plants, vegetables, and fruits and many hundreds of recipes.

DRAWINGS OF BRITISH PLANTS: BEING ILLUSTRATIONS OF THE SPECIES OF FLOWERING PLANTS GROWING NATURALLY IN THE BRITISH ISLES. Part XV. Compositae (1). Ross-Craig, Stella. 28 plates, indexed. G. Bell and Sons, London. 1960. $1.40

Species of the genera *Eupatorium, Solidago, Bellis, Aster, Erigeron, Filago, Antennaria, Gnaphalium, Inula, Pulicaria, Bidens,* and *Galinsoga.* The work of one of Britain's foremost botanical artists.

HAWAII BLOSSOMS. Hargreaves, Dorothy and Bob Hargreaves. 64 pages, illustrated in color, bibliography. Hargreaves Industrial, Portland, Ore. 1958. paper: $2.00; cloth: $3.50

Over 100 illustrations in color of trees, shrubs, vines, and other plants growing in Hawaii. A brief descriptive text often includes specific locations.

HAWAIIAN FLOWERS AND FLOWERING TREES; A GUIDE TO TROPICAL AND SEMITROPICAL FLORA. Kuck, Loraine E. and Richard C. Tongg. 158 pages, illustrated in color, indexed. Charles E. Tuttle Co., Rutland, Vt. 1960. $2.45

An inexpensive, soft-cover edition with identical contents as the clothbound which was published in 1958. A most useful, well-illustrated guide for travelers in the tropics and subtropics.

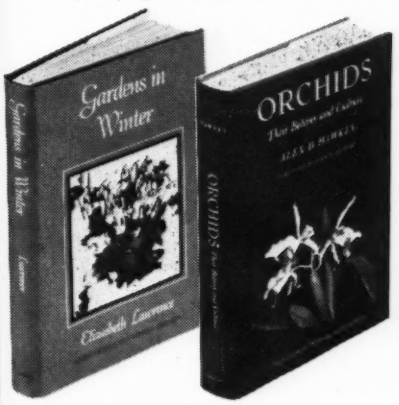
HIGH SIERRA MOUNTAIN WONDERLAND. Wampler, Joseph C., W. F. Heald, and Charles McDermand. 122 pages, illustrated, bibliography. Joseph C. Wampler, Berkeley, Cal. 1960. $2.00

Flowers, mammals, birds, fishes, geology, and weather of the country of the famous John Muir Trail in California—a most informative guide by three westerners who know and love these mountains. Good historical background.

MEET THE SOUTHWEST DESERTS. Welles, Philip. 82 pages, illustrated, bibliography, indexed. Dale Stuart King, Globe, Arizona. 1960. paper: $1.00; cloth: $2.25

This booklet is an introduction to the plant

Admirable new books for gardeners



GARDENS IN WINTER

By ELIZABETH LAWRENCE, author of *The Little Bulbs.* Miss Lawrence, as the *Chicago Tribune* says, "writes enchantingly, betraying her own enthusiasm while imparting fundamental information." In her new book she gives practical advice on how to extend bloom and color beyond the fall frosts and how to start it ahead of spring. Here are ideas for the South, New England, the Central States, the West Coast — plants effective against a wall, species for sheltered corners, evergreens and vines for color. And Miss Lawrence combines fresh suggestions with notes on customs and uses of the past. *26 line drawings by* CAROLINE DORMON. $4.50

ORCHIDS

Their Botany and Culture

By ALEX D. HAWKES. The Editor of *Orchid Journal* and *Orchid Weekly* presents the most comprehensive, up-to-date, popular book in the field. For the beginner, it offers concise guidance on where orchids are to be found, classification and naming systems, housing, care, and propagation. For experienced orchidists, it treats in detail more than 100 genera, covering native range of favorite species, common characteristics, requirements for cultivation, and hybridization. "A wealth of information in a clear and understandable manner ... I liked very much his treatment and arrangement of the whole complex subject." — FRANK H. OVERTON, Former Editor, *The Bromiliad Bulletin. 150 black-and-white photographs and drawings; full-color frontispiece.* $6.95

Incomparably useful

ARRANGING FLOWERS FOR THE SANCTUARY

By FRANCIS PATTESON-KNIGHT and MARGARET M. ST. CLAIRE

Illustrated $3.50

At all bookstores

HARPER & BROTHERS, N. Y. 16

and animal life in the Southwest desert country below forty-five hundred feet elevation. Philip Welles grew up in the Sierre Madre and studied at the University of Arizona and is at present with the National Park Service. Good photographs.

MY WILDERNESS; THE PACIFIC WEST. Douglas, William O. 206 pages, illustrated. Doubleday and Co., Garden City, N. Y. 1960. $4.95

A dramatic, sympathetic account of the great out-of-doors as experienced by our "walking Justice" who has tramped through vast wildernesses from the Sierras in California north to the Olympics in Washington. A wonderful antidote for that pent-up feeling.

THE OXFORD BOOK OF WILD FLOWERS. Ary, S. and M. Gregory, eds. 232 pages, illustrated, mostly in color, indexed. Oxford University Press, New York, N. Y. 1960. $7.50

Rarely do we come across such a superb book which is useful to the layman-lover of native plants. Arranged by color sequence, non-technical text, and a comfortable size. Five hundred and fifty species of the wild flowers of the British countryside are exquisitely and accurately illustrated in soft, full color and thirty more in black and white, with many less common ones described in the text. Although definitely slanted for use in Great Britain, a suprisingly large number of these flowers from across the sea also grow in American fields and gardens.

TROPICAL BLOSSOMS OF FLORIDA. Hargreaves, Dorothy and Bob Hargreaves. 64 pages, illustrated in color, bibliography. Hargreaves Industrial, Portland, Ore. 1960. paper: $2.00; cloth: $3.50

Over one hundred full-color pictures with brief descriptive notes of tropical Florida flora. This booklet is identical with *Tropical Blossoms of the Caribbean* except for the title.

TROPICAL BLOSSOMS OF THE CARIBBEAN. Hargreaves, Dorothy and Bob Hargreaves. 64 pages, illustrated in color, bibliography. Hargreaves Industrial, Portland, Ore. 1960. paper: $2.00; cloth: $3.50

This booklet is identical with *Tropical Blossoms of Florida* except for the title.

YOUR GARDEN IN THE SOUTH. Mason, Hamilton. 358 pages, illustrated, part colored, bibliography, indexed. D. Van Nostrand Co., Princeton, N. J. 1961. $7.75

This is a book to recommend to the northerner who is moving south to Florida, Alabama, Georgia, Louisiana, Mississippi, or eastern Texas. The author writes: "You can have some of the North's favorite plants in parts of the South, but the farther you go into warm territory, the fewer you can have. You will learn . . . that lilacs, lily-of-the-valley, peonies must become fond memories. But what an enormous wealth of plants you have to replace them." Fruit and nut trees, ornamental trees, shrubs, vines, perennials, annuals, and lawns are well covered, but there is no mention of vegetables.

Economic Plants

THE MANGO; BOTANY, CULTIVATION, AND UTILIZATION. Singh, Lal Behari. 438 pages, illustrated, part colored, bibliography, indexed. Interscience Publishers, New York, N. Y. 1960. $13.25

Another welcome addition to the World Crops Books Series, edited by Nicholas Polunin. Mr. Singh, who is the Director of the Horticultural Research Institute, Saharanpur, Uttar Pradesh, India, has produced an up-to-date, noteworthy monograph on this important tropical fruit.

PRODUCING FARM CROPS. Wilson, Harold K. and A. Chester Richer. 336 pages, illustrated, bibliography, indexed. Interstate Printers and Publishers, Danville, Ill. 1960. $4.50

A textbook on modern methods of cultivation, designed primarily for high school agricultural students, written by experienced teachers of the Pennsylvania State University. A good discussion of the history, botany, genetics, and chemistry of grain and fodder crops is included.

THE WINE COUNTRY OF FRANCE. Hyams, Edward. 208 pages, maps, indexed. J. B. Lippincott Co., Philadelphia, Pa. 1960. $4.50

Well known as a novelist, Edward Hyams is also a viticulturist with an extensive vineyard in East Kent. Here is a rare combination of fine writing on a subject concerned with beautiful country and delectable wines.

Nature Study

BACKYARD BIRDS. Thomas, Arline. 46 pages, illustrated, part colored, bibliography, indexed. Sterling Publishing Co., New York, N. Y. 1960. $1.00

A little handbook of birdhouses, feeders, food preferences, first-aid hints for injured birds. Excellent line drawings, diagrams, and a few photographs in color of our common birds.

FAMILIAR INSECTS OF AMERICA. Barker, Will. 236 pages, illustrated, part colored, bibliography, indexed. Harper and Bros., New York, N. Y. 1960. $4.95

Companion book to the author's *Familiar Animals of America*—interesting reading and excellent illustrations.

A GATHERING OF SHORE BIRDS. Hall, Henry Marion. 242 pages, illustrated, bibliography, indexed. Devin-Adair Co., New York, N. Y. 1960. $10.00

Roland C. Clement of the staff of the National Audubon Society has edited this work and added valuable data on migration and behavior of the shore bird family. Here is a fine combination of popular and scientific presentation.

THE NEW HANDBOOK OF ATTRACTING BIRDS; 2nd ed. McElroy, Thomas P. 262 pages, illustrated, bibliography, indexed. Alfred A. Knopf, New York, N. Y. 1960. $4.00

The first edition appeared in 1950 under the title *Handbook of Attracting Birds*. The present revision is much enlarged.

WILDFLOWERS OF NORTH AMERICA. Lemmon, Robert S. and Charles G. Johnson. 280 pages, illustrated in color, bibliography, indexed. Hanover House, Garden City, N. Y. 1961. $9.95

The four hundred and forty color photographs are the work of Charles C. Johnson and his wife, who travelled over two hundred thousand miles throughout continental United States to locate and take pictures of America's best-known native wildflowers. The text was written by Robert S. Lemmon, from whose pen have come many fine books. This present volume is divided into five main sections: 1. The Coastal Region; 2. The Deserts of the Southwest; 3. The Mountains; 4. The Prairies; 5. The Woods. We have had few books of our native flora with such a wide scope, and this combination of splendid photographs and accurate text should find many followers.

THE WONDERS I SEE. Terres, John K. 256 pages, illustrated, bibliography, indexed. J. B. Lippincott Co., Philadelphia. 1960. $5.00

Fascinating observations from the daily journal of the former editor of *Audubon Magazine*, delightful reading of plant and animal life. For the most part, Mr. Terres writes from his home on Long Island, but there are frequent treks up through New England and down to Florida.

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For Young Readers

ABOUT APPLES FROM ORCHARD TO MARKET. Mary Moore Green. 31 pages, colored illustrations. Carl J. Leibel, Puente, Cal. 1960. $2.50

A young child can learn much from this story of the seasonal operations in a modern apple orchard in Michigan. Pruning, spraying, fertilizing, harvesting, grading, storing and shipping are some of the routine jobs. Pleasingly illustrated.

ABOUT THE VEGETABLES ON YOUR PLATE. Allee, Veva Elwell. 32 pages, illustrated, Carl J. Leibel, Puente, Cal. 1960. $2.50

"Look, read, learn" series. First steps in botany from everyday vegetables with a little bit on shipping, storing, dehydrating, canning and freezing.

ADVENTURE BOOK OF FOREST WONDERS. Evans, Eva Knox. 94 pages, illustrated, indexed. (in "Adventure Kit of Forest Wonders"). Affiliated Publishers, New York, N. Y. 1960. Adventure kit with book: $2.95

The "Adventure Kit of Forest Wonders" contains a well-illustrated paper-bound book, full of interesting facts about trees and of suggestions for doing experiments, such as making paper, starting wood specimen collections. The kit contains samples of wood pulp, wheat paste, peat planting pot with tree seeds, and other equipment. This book can be obtained only at bookstores.

THE GOLDEN BOOK OF NATURE CRAFTS: HOBBIES AND ACTIVITIES FOR BOYS AND GIRLS. Saunders, John R. 68 pages, colored illustrations, bibliography. Affiliated Publishers, New York, N. Y. 1958. $1.95

Wonderfully well-done by the Chairman of the Department of Public Instruction of The American Museum of Natural History. Plant subjects include: "Window Gardens from Kitchen Cuttings," "Making Leaf Prints," "Eggshell Gardens," "Make Seeds Sprout," "Making a Desert Garden Indoors," "Let's Go Nutting." This book can be obtained only at bookstores.

GRASSES. Eberle, Irmengarde. 56 pages, illustrated. H. Z. Walck, New York, N. Y. 1960. $2.75

A simple storybook for ages seven to ten about some members of the grass family, such as rice, corn, wheat, and bamboo as well as the "true" grasses.

HIGH TIMBER; THE STORY OF AMERICAN FORESTRY. Coombs, Charles I. 224 pages, illustrated, indexed. World Publishing Co., Cleveland, Ohio. 1960. $4.95

A serious book for the "teen-ager" with particular emphasis on the importance of trees, their many uses, their conservation, and their classification. Duties and qualifications of a forest ranger are discussed at length.

HOW A SEED GROWS. Jordan, Helene J. unpaged, illustrated, part colored. Thomas Y. Crowell Co., New York, N. Y. 1960. $1.95

A "beginning-to-read" picture book.

HOW THINGS GROW. Zim, Herbert S. 64 pages, illustrated. William Morrow and Co., New York, N. Y. 1960. $2.50

The many ways of growth in plants and animals are described and illustrated in a manner to hold the interest of young children.

IN MY GARDEN. Zolotow, Charlotte, unpaged, illustrated, part colored. Lothrop, Lee and Shepard Co., New York, N. Y. 1960. $2.75

Another picture book for the very, very young.

INSTRUCTIONS TO YOUNG BOTANISTS. Duddington, C. L. 128 pages, illustrated, bibliography, glossary, indexed. Sportshelf, New Rochelle, N. Y. 1960. $3.75

Dr. Duddington, a teacher of botany in London, has written a good introduction to the study of plants and covers such subjects as morphology, physiology, simple classification, plant distribution, and collecting.

JOHNNY APPLESEED. Norman, Gertrude. 45 pages, illustrated. G. P. Putnam's Sons, New York, N. Y. 1960. $2.00

The story of how Johnny Appleseed (John Chapman was his real name) went west into the Ohio territory and broadcasted his apple seeds wherever he traveled. For the beginning reader.

JUNIOR SCIENCE BOOK OF TREES. Lemmon, Robert S. 63 pages, illustrated, part colored, indexed. Garrard Press, Champaign, Ill. 1960. $2.25

Mr. Lemmon writes simply but authoritatively on tree seeds, roots, and leaves and clearly describes the fundamentals of tree growth and physiology. He emphasizes the importance of trees. The illustrations are good.

MEADOWS IN THE SEA. Malkus, Alida S. 72 pages, illustrated, part colored, indexed. World Publishing Co., Cleveland, Ohio. 1960. $2.75

Microscopic animals and plants, living in the underwater world, are accurately illustrated and described. Written for the junior naturalist, this is a fine addition for the nature-study shelf.

PAPER. Meyer, Jerome S. 93 pages, illustrated, indexed. World Publishing Co., New York, N. Y. 1960. $3.50

A dramatic history of paper beginning with the very first papermaker, the wasp. Modern methods are explained in detail and are well illustrated by photographs. According to Mr. Meyer's statistics "a typical American family of four uses approximately 1,700 pounds of paper a year."

PENNY THE MEDICINE MAKER; THE STORY OF PENICILLIN. Epstein, Sherrie S. unpaged, colored illustrations. Medical Books for Children, Minneapolis, Minn. 1960. $2.75

Penicillium notatum, or Penny for short, the good germ, is blown through an open window into Dr. Fleming's lab. In due time there is a battle between Penny's good gang and the bad germs, namely, Strep, Pneumos, and the Staph. An exciting little story of an elementary grade. At the end of the book is a supplementary page for grown-ups, which gives a brief history of the discovery of penicillin.

BOOKLETS

Catalog of Hardy Trees and Shrubs, a list of the woody plants grown outdoors at the Garden in 1942. Illus. Price 75¢ per copy.

Hardy Ferns and Their Culture. Illus. Price 25¢ per copy.

Flora of the Unicorn Tapestries. Illus. Price 25¢ per copy.

Food and Drug Plants of the North American Indians. Price 25¢ per copy.

Montgomery Conifer Collection, non-technical descriptions of conifers with information on history, habitat, and usage. Illus. Price 50¢ per copy.

Plants of the Holy Scriptures. Price 25¢ per copy.

Succulent Plants of New and Old World Deserts. Illus. Price 50¢ per copy.

Vegetables and Fruits for the Home Garden. Price 25¢ per copy.

Also reprints of well-illustrated, step-by-step articles on different garden techniques, written and photographed by T. H. Everett, Assistant Director (Horticulture): "Lawn Verges," "How to Force Dutch Bulbs" (in the home), "Some Sources of Humus," "Tree Pruning Pointers," "Sowing Seeds in Flats," "How to Transplant," "Some Fall Gardening Work" (i.e. heeling in, root cuttings, bulbs in pebbles), "Winter Protection of Plants."

10¢ each — any 6 reprints 50¢

The above booklets and reprints are obtainable from The New York Botanical Garden

THE NEW YORK BOTANICAL GARDEN

BRONX PARK NEW YORK 58, N. Y.

MEMBERSHIP

We were delighted to welcome the following new members between October 1, 1960, and December 31, 1960.

NEW MEMBERS:

Life
Mrs. Armand P. Bartos*
Mrs. Edward S. Crocker

Contributing
Charles Jay Oppenheim III*
Mrs. Taggart Whipple

Garden Club
The City Gardens Club

Husband and Wife
Mr. and Mrs. Lyndon O. Brown
Mr. and Mrs. William J. Dear, Jr.
Dr. and Mrs. Harry K. Fong
Mr. and Mrs. Carl G. Hornwood
Mr. and Mrs. Kalman V. Illyefalui
Mr. and Mrs. Sam Kollar
Mr. and Mrs. John Mayer
Mr. and Mrs. E. C. Mehrof
Dr. and Mrs. George L. McNew
Mr. and Mrs. Arthur Ohringer
Mr. and Mrs. B. F. Parker
Mr. and Mrs. Dan Rodgers
Mr. and Mrs. Henry S. Sayers

Annual
Mrs. Henry Aranow, Jr.
Miss Esther Barag
Mrs. Charles Banks Belt
Fred L. Caplan
Mrs. George Champion
Mrs. Gerald J. Curtin
Mrs. Geoffrey Davey
Mrs. K. Delbanco
Robert W. Fiddler
Mrs. Marcus S. Friedlander
Mrs. Robert E. Gillie
Dr. A. R. Goldsby
G. Mason Gross
Meyer Hack
Miss Margaret Haegel
Mrs. Hubert Hecht
Mrs. S. Hershkowitz
Mrs. Alfred F. Intemann
Mrs. Jean Jones
Mrs. L. E. Lynch, Jr.
Mrs. Kirby A. Martin
Mrs. Walter Maynard
Mrs. Catherine Morrissey
James R. Myles
Mrs. Stanley Newhouse
Charles G. Pitts
Dr. Frank J. Pokorny
Miss Anne B. Raleigh
J. L. Roberts
Miss Beryl Robichald
Miss Lucille P. Ross
Miss Blanka Rothschild
Mrs. O. Gayda Rubino
Dr. Harry Scher
Miss Vivian Sherman
Mrs. Dorothy A. Stark
Charles Squires
Miss A. L. Stausbury
Mrs. Martin D. Stein
Mrs. John C. Swartley
Dr. Terence Lloyd Tyson
Mrs. Marion Viccars
Mrs. Muriel Watsky
Mrs. Blanche Weisman
Mrs. Philip D. Wiedel
Charles R. Wood
Miss Helen Ziegel

*Change in classification

NEWS, NOTES and COMMENTS

Activities of the Director and Staff. Within recent months, Dr. William C. Steere, Director, visited the Museum of Comparative Zoology at Harvard University, Cambridge, Massachusetts, and the Academy of Natural Sciences, Philadelphia, at the request of the National Science Foundation; attended many of the meetings, luncheons, and dinners of the American Association for the Advancement of Science, held in New York City, during which he addressed the National Association of Biological Teachers on "Biological Problems in Alaska." Several other members of the staff also attended the AAAS meetings.

Dr. Steere attended a panel meeting of the Special Facilities Program of the National Science Foundation in Washington, D.C.; a meeting of the Advisory Committee of the Biological Sciences Communications Project at Stanford University; and a meeting of the Steering Committee of the Biological Sciences Curriculum Study Committee at Boulder, Colorado.

Dr. Harold William Rickett, Acting Assistant Director (Botany) and Bibliographer, used the facilities of the Gray Herbarium and Library in Cambridge, Massachusetts, for a week in December. Dr. Rickett lectured at a recent meeting of the Southampton Garden Club held in New York City.

T. H. Everett, Assistant Director (Horticulture) and Curator of Education, was one of the speakers at a luncheon-meeting at the Brooklyn Botanic Garden, called by Dr. George T. Avery, Director, to consider the future objectives of garden and horticultural writers and teachers. Dorothy Ebel Hansell, Editor of *The Garden Journal,* also attended this interesting session.

Dr. P. P. Pirone, Plant Pathologist, gave a talk at the annual dinner-meeting at the Westchester Mens' Garden Club, at New Rochelle, New York, on "What's New in Gardening."

Dr. David J. Rogers left the last week in January for a two-months collecting trip in Brazil. Dr. Rogers will collect specimens of *Manihot esculenta* and related species for systematic investigation under a grant from the National Science Foundation.

Dr. Bassett Maguire, Head Curator and Coordinator of Tropical Research, will speak on "Some Flowering Plants of the South American Tropics" in the Colonial Williamsburg Symposium, Williamsburg, Virginia, on March 23, 1961.

Dr. Arthur Cronquist delivered several lectures at a well-attended seminar of faculty and students of the Department of Botany, University of Michigan, Ann Arbor, and consulted with Dr. W. H. Wagner while there. Dr. Cronquist spent several days in the Gray Herbarium and Library, at Cambridge, Massachusetts, in research on the intermountain flora.

Dr. Herman F. Becker, Visiting Research Associate, contributed a paper on "Paleobotanical Records of Solar Changes" in the section on "Polynology, Dendrochronology, and Varve Chronology" in the symposium of the New York Academy of Sciences, New York City, January 25-28, 1961.

Miss Elizabeth Hall, Sarah Gildersleeve Fife Memorial Librarian, gave three lectures on "Fragrance in the Garden"—one in the Downtown Lecture Series, one before the Little Gardens Club in New York City, and one at St. Barnabas Hospital, New York City.

Miss Georgia Manos who has been working as a graduate student in the Research Laboratory under Dr. Richard M. Klein, Alfred H. Caspary Curator, received her doctorate from Fordham University in January, 1961. She prepared her thesis on "The Effects of Growth Substances on Attached and Detached Roots of *Pisium sativum*." Dr. Manos will join the faculty of the College of Osteopathic Physicians and Surgeons in Los Angeles, California, in September 1961 as an instructor in physiology.

Grant to the Garden. The National Science Foundation, through its Support of Scientific Publications, has awarded a substantial grant to The New York Botanical Garden for the preparation and publication of an international plant index by the use of punched cards and data processing machines. Sydney W. Gould, the principal investigator, will carry on much of the work at the Connecticut Agricultural Experiment Station, co-sponsor of this research program.

Citations of Merit to Mrs. Place and Mrs. Clark. The American Scenic and Historic Preservation Society presented Citations of Merit to Mrs. Hermann G. Place and Mrs. Leroy Clark. The presentations were made by A. Hamilton, the Society's President, at the medals award luncheon on January 18, 1961, which Dr. Steere attended. Mrs. Place is a Vice President of The New York Botanical Garden and a member of the Advisory Council. Mrs. Clark is a member of the Advisory Council.

Mr. Hamilton, in presenting the citation to Mrs. Place said: "Mrs. Place has distinguished herself in many fields of public service, including her important work with the Garden Club of America, The New York Botanical Garden, and the National Arboretum.

"This Society, however, desires at this time to honor her for her outstanding contributions to historic preservation, especially through The National Trust for Historic Preservation in the United States. Her service to this cause in her capacities as Trustee, Executive Committee member, and Vice-Chairman of the National Trust has been prodigious. She has brought to this work not only unusual knowledge of historic houses and gardens in America, but also the benefits of extensive travel and observations in Great Britain and Europe. To this knowledge has been added exceptional judgment and leadership with a dedicated devotion of time and resources.

"As a Society created to promote preservation, and as one of the founding members of the National Trust, The American Scenic and Historic Preservation Society honors Mrs. Place

for her great contributions to the public good in this field."

The citation reads: "To Angela Moore Place. For her distinguished accomplishments in the field of conservation through the media of The Garden Club of America, The New York Botanical Garden, and The National Arboretum, and for her stimulating leadership and ardent enthusiasm in the field of Historic Preservation as Trustee, member of the Executive Committee and Vice Chairman of The National Trust for Historic Preservation in the United States."

In presenting the citation to Mrs. Clark, Mr. Hamilton said: "America is fortunate in the interest that her women take in civic, religious, and political affairs. Women have long been leaders in the cause of conservation of natural resources. In their garden clubs and local women's clubs and the national federations with which they are affiliated, they have sponsored their own conservation programs and have supported those of other organizations which have had local or country-wide significance.

"They have been effective champions of national and state park programs, the protection of wildlife and the restoration of historic sites and structures. It is a high privilege to honor one of these leaders today.

"She is a dedicated conservationist, long active in the Garden Club of America. She has served on its Conservation Committee as a specialist in national park affairs. She has been chairman of the Parks Committee. In 1957 she was awarded the Margaret Douglas Medal by the Garden Club of America for notable service to the cause of conservation. She is familiar with nature reservations in foreign lands, having been a member of the Copenhagen Assembly of the International Union for the Conservation of Nature and Natural Resources. For many years, she has been the President of the Palisades Nature Association, and was most influential in the public relations activities that assured New Jersey support for the Palisades Interstate Parkway. Her wise counsel guided the Park Commission in the establishment of the Greenbrook Sanctuary. Her interest has extended to the National Arboretum in the Nation's Capitol.

"Always gracious, always patient, always cooperative, always carrying her full share of responsibility in any project, but always avoiding public applause, this charming lady, Edna Ames Clark, is accorded the admiration and praise of the trustees and membership of The American Scenic and Historic Preservation Society for her leadership and outstanding achievements in the field of resource conservation."

The citation reads: "To Edna Ames Clark. For her lifetime devotion to the field of Conservation and her exemplary accomplishments via active participation in civic, wildlife, and garden organizations, and in particular for her leadership in The Garden Club of America and the Palisades Nature Association."

The Association of Museums of New York State was officially launched on January 13, 1961. Dr. Steere, Director of The New York Botanical Garden, was elected president.

A committee was appointed to survey the needs and functions of museums within the state, and to establish a criterion for the name museum.

Museum Advisory Council. Harold K. Hochschild, a founder of the Adirondack Museum and President of the Adirondack Historical Association, was appointed chairman of the advisory committee by Dr. James E. Allen Jr., State Education Commissioner. The members of this committee include Dr. Steere, Dr. James A. Oliver, Director of the American Museum of Natural History; W. Stephen Thomas, Director of Rochester Museum of Arts and Sciences; J. H. G. Pell, Managing Director of Fort Ticonderoga Association; James J. Rorimer, Director of the Metropolitan Museum of Art; and Rene d'Harnoncourt, Director of the Museum of Modern Art in New York City.

Dr. Hugh M. Flick, Associate Commissioner of Education, and staff members of The New York State Museum and the State Education Department will work with this committee in studying the needs and contributions of museums in New York State and in developing ways to strengthen the museum programs.

The Torrey Botanical Club held a very successful symposium during the meetings of the American Association for the Advancement of Science in New York City last December. About three hundred attended the morning and afternoon sessions at the Hotel Biltmore; and one hundred and fifty-six guests at the luncheon heard Dr. Barry Commonor, of Washington University, St. Louis, Missouri, deliver a stimulating and provocative talk "In Defense of Botany." It was Dr. Commoner's address as retiring president of the Botanical Society of America. Dr. Steere presided at the luncheon in the absence of Dr. Charles Berger, the Club's President.

The annual meeting of the Club, held at the Faculty Club, Columbia University, on January 17, 1961, was well attended. Dr. Clarke T. Rogerson, the Secretary, read the names of one hundred and forty-nine applicants who were accepted for membership, the result of a recent membership drive directed by Dr. Steere, Chairman of the Membership Committee. Dr. Charles Berger, Chairman of the Department of Biology at Fordham University, gave his address as retiring president; his subject was "Cytological Features of Plant Development."

Elected to office were: Dr. William C. Steere, President; Dr. Lindsay S. Olive, Vice President; Dr. Annette Hervey, Corresponding Secretary; Miss Mathilde P. Weingartner, Recording Secretary; Dr. Rita M. McMahon, Treasurer; Dr. James Gunckel, Editor; Howard Swift, Manager of Publications; Dr. Clark T. Rogerson, Bibliographer; Dr. Harold William Rickett, Historian; Dr. Lela V. Barton, member of the Board of Managers of The New York Botanical Garden.

At the meeting on February 7, Carl J. Schiff, Director of Horticulture for the Department of Parks, New York City, discussed "Some Aspects of the Horticultural Activities of the Department of Parks." At the meeting on February 21, Dr. Richard C. Staples, of Boyce Thompson Institute for Plant Research, presented "Some Physiological Comparisons between the Conidia of *Aspergillus niger* and the Uredospores of the Bean Rust Fungus."

The spring program follows: March 7, Dr. Carl L. Withner of Brooklyn College—Brooklyn Botanic Garden, on "Introgression in Cattleya Orchids"; March 21, Ernest Guenther, Vice President and Technical Director of Fritsche Bros. Inc., on "Essential Oils of Africa"; April 18, F. Gordon Foster, of Bell Telephone Laboratories, on "Our Northern Ferns and Their Identifications"; and May 16, Dr. Bassett Maguire, Head Curator and Coordinator of Tropical Research at The New York Botanical Garden, on "Flowering Plants of Guyana."

The Sixteenth International Horticultural Congress will be held in Brussels, Belgium, August 31-September 8, 1962, under the auspices of the International Society for Horticultural Science. The Society, founded in April 1959, took over the activities of the International Committee for Horticultural Congresses.

Sections of the plenary sessions will be devoted to vegetable culture, fruit culture, floriculture, nursery, tropicals and subtropicals. Special group meetings are planned as well as a general assembly and reunions of commissions. There will be excursions to horticultural centers, research institutions, and tourists' attractions.

Those who wish to present a scientific paper are requested to send the exact title and a resume of two hundred words to the Secretary-General, 233 Coupure links, Ghent, Belgium, not later than June 30, 1961. If possible, the resume should be submitted in the three official languages of the Congress—English, French, and German.

The American Iris Society, with the assistance of The New York Botanical Garden, will celebrate the Society's forty-first anniversary at its birthplace on May 26, 1961. The Society was founded on January 29, 1920, at a meeting held at the Garden and arranged by Dr. H. A. Gleason, Dr. John C. Wister, and the late Frank B. Presby. The Presby Memorial Iris Garden in Montclair, New Jersey, is named in his honor.

Dr. Gleason, noted botanist and author of many scientific publications, is Curator Emeritus of The New York Botanical Garden. Dr. Wister is Director of the Arthur Hoyt Scott Horticultural Foundation at Swarthmore, Pennsylvania. They will be honored at special exercises to be held in the Lecture Hall of the Museum and Administration Building on the afternoon of May 26. Mrs. Ethel Anson Peckham, Honorary Curator of the iris and narcissus collections at the Garden, will also be honored on that occasion. Mrs. Peckham took an active part in the first trial garden of the American Iris Society that was started at The New York Botanical Garden in August, 1920.

The Garden's extensive iris borders have been made ready for the visit of hundreds of iris growers from all parts of the United States. The borders, now located on the upper terrace around the Conservatory, extend five hundred feet or more on each side of a wide path. They are filled with more than twenty-five hundred plants representing six hundred and thirty varieties. Many of the plants have been contributed by officers and members of the American Iris Society, by the Arthur Hoyt Scott Horticultural Foundation, and by Cedar Brook Park Iris Garden through Miss Harriette R. Halloway with the approval of the Park Department and the Plainfield Garden Club.

Mr. Everett is a special member of the Committee on Arrangements, representing The New York Botanical Garden. Mrs. Hansell is Vice

Chairman, as is Mrs. F. P. Walther of the Presby Memorial Iris Garden, under Mrs. Kenneth Smith of Dongan Hills, Staten Island, General Chairman. John Gatty, of Fairlawn, New Jersey, Vice President of Region 19 of the American Iris Society, in which the four-day annual meeting will be held, is an advisory member of the Committee on Arrangements as are other regional officers.

The International Rhododendron Conference will be held at the Multnomah Hotel, Portland, Oregon, May 11-14, 1961. Among the talks scheduled on the program are: "Rhododendrons and Azalea Varieties for the West Coast" by P. H. Brydon, Director of Stryberg Arboretum, San Francisco; "Rhododendrons at the Royal Botanic Garden, Edinburgh and Benmore" by Dr. H. A. Fletcher, Regius Keeper of the Royal Botanic Garden, Edinburgh; "Rhododendron and Azalea Trials at Wesley" by Dr. F. P. Knight, Director of the Royal Horticultural Society Gardens; "Rhododendrons and Azaleas in New Zealand" by Dr. J. S. Yeates of Massey Agricultural College, Palmerston, New Zealand; "The Dexter Hybrids Today" by Dr. John C. Wister, Director of the Arthur Hoyt Scott Horticultural Foundation, Swarthmore, Pennsylvania; and "Classification of the Native American Azaleas" by Dr. Henry T. Skinner, U. S. National Arboretum, Washington, D. C.

Dr. Clement G. Bowers of Maine, New York; Joseph B. Gable of Stewartstown, Pennsylvania; Rudolph Henry of Brooks, Oregon; A. M. Shammarello of Euclid, Ohio; and H. L. Larson of Tacoma, Washington, will participate in the symposium on "Breeding Developments in the United States."

The conference program provides for a visit to the National Test Garden of the American Rhododendron Society, located on an island in Crystal Springs Lake in the Eastmoreland section of Portland. The first planting was made in 1950. Today there are about three thousand plants; these include two hundred and twenty-five species and three hundred named varieties. Practically all the series are represented. A quonset-type building with a plastic roof, and electrically heated and ventilated, was erected in 1956 to accommodate tender rhododendrons. The building is also used for the annual show of the Portland Chapter of the American Rhododendron Society.

The Horticultural Society of New York at its annual meeting, held on January 18, 1961, presented special awards to Harold Epstein as "an amateur horticulturist of outstanding ability," to Alfred B. Graf "for outstanding accomplishments and contributions as a professional horticulturist," and to the Worcester County Horticultural Society "for outstanding contribution in extending horticultural interest and education."

Mr. Epstein, a member of The New York Botanical Garden, is a "member of a large number of both foreign and domestic plant and horticultural societies. He is most active in the American Rock Garden Society . . . He is past president of the Mens' Garden Club of New York and of the Northeast Chapter of the American Rhododendron Society. He organized the Hortus Club of New York of which he is president, and he is also currently president of the Greater New York Orchid Society.

"Sometimes it is impossible to make a fine distinction between the amateur and the professional horticulturist, for often one invades the field of the other. We find ourselves in this dilemma in properly cataloguing Harold Epstein. Too often the word 'amateur' is applied to the novice or inexperienced, whereas the true definition which fits him stems from the Latin "amator," or lover; that is, one who practices an art not professionally, nor for profit, but for the love of it. No amateur horticulturist has pursued his avocation with more thoroughness, zeal, intelligence, devotion, and resourcefulness than has Mr. Epstein.

"His interest and curiosity led him to specialize and concentrate on ericaceous plants with accent on the dwarfer rhododendrons and azaleas. In addition, he has demonstrated a keen interest in and knowledge of lilies, primulas, ferns, hardy small bulbs, and choice dwarf shrubs, particularly Japanese.

"Today his garden, a miniature arboretum, boasts of being one of the finest private collections of choice and unusual plants. . .

"Alfred Graf has to his credit the collecting and introduction of a large number of tender flowering and foliage plants, which resulted from his numerous trips to practically every tropical and subtropical country of the world. These were obtained from botanical gardens, herbaria, private collections, the market places, and native habitats.

"Another important result of his exploration and knowledge of tender plants is his writing of several books, the most ambitious one being *Exotica*. . ."

"The history of the Worcester County Horticultural Society is both interesting and unique. . .

"The success of a fair in 1870 in the old town hall on Worcester Commons, to raise funds for the completion of the Bunker Hill Monument, inspired William Lincoln to hold a purely horticultural show. From an admission price of 12½ cents, a $20 .99 profit was realized; at the conclusion of the exhibit Horticultural Society had its inception.

"In addition to being an architectural gem, it [Horticultural Hall, built in 1928] is said to be the most beautiful and finest of its kind. Based on a per capita membership, the financial statement indicates that it is also the wealthiest horticultural society in the world. The founders would indeed be proud and overwhelmed with the growth of their original investment 121 years ago. The Society is entirely independent of income from dues, which are only a dollar a year per member.

"Work with children and young people has been an ideal of the Society ever since its inception and the many activities provided for them is one of the most rewarding services. . .

"A most unusual, interesting, and useful activity of the Society is its experimental orchard of old apple varieties. . ."

Conference on Palaeo-climates. The New York Academy of Sciences, from January 24-28, 1961, held a conference on "Solar Variations, Climatic Change, and Related Geophysical Problems," with all sessions at the Barbizon Plaza Hotel in New York City. Participating organizations were the Section of Geological Sciences, the Division of Oceanography and Meteorology, and the American Meteorological Society of Boston, Massachusetts. The conference was organized and chaired by Dr. Rhodes W. Fairbridge of Columbia University. With representatives from fifteen states of the Union, and scientists from Australia, Belgium, Canada, England, Germany, Hungary, Italy, Netherlands, Russia, and Venezuela, the gathering assumed a truly international aspect.

Among a score of outstanding papers, several concerned themselves with palaeobotanical and with cultural aspects since the last interglacial and postglacial time. Evidence, partially based on the Carbon^{14} method, corroborates and refines known facts in archaeology and anthropology, and sheds new light on climatic cycles. Faunal evidence in relation to climatic fluctuations was presented through mammalian and invertebrate remains (C. Emiliani, University of

The National Test Garden of the American Rhododendron Society in Portland, Oregon.

Miami; F. E. Ze ner, University of London, En[illegible] and others); floral aspects through tree ring studies (D. J. Schove, St. David's College, Kent, England); and palynology (M. B. Davis, P. B. Sears, Yale University). The New York Botanical Garden was represented by the author who presented the taxonomic problem of macro-palaeobotany in establishing palaeoclimates.

Admittedly (M. B. Davis) pollen diagrams as evidence of climatic changes still leave much to be desired, and much more accurate methods of interpretation must be devised before palynology may realistically defend its hypotheses. Macro-palaeobotany, in this respect, has come of age. The paper on "Palaeobotanical Record of Solar Change" (author) was enthusiastically received, caused many favorable comments about validity in relation to climate determination, and is acknowledged to present one of the irrefutable, direct evidences based primarily on ecological comparisons with living plant associations. All fossil assemblages in the world contribute partially to the interpretation of climatological events. An exacting inference begins with the appearance of angiosperms in the late Cretaceous and becomes more accurate, even irrevocable, during the sequence of Tertiary epochs. Palaeobotanical structures of the Tertiary assume a progressively modern aspect expressed in morphological structures of leaves, flowers, bracts, fruits, and seeds which mirror taxonomically existing floras that are adapted to a specific climatic environment. Through fossil taxonomy a further accurate interpretation of evolution, migration, topography, precipitation, and climate, as a whole, is possible. A fossil flora which is generally analogous to a comparable living association is expected to have lived under similar climatic conditions. All Teritiary floras fit into this pattern, of which the Lower Eocene Ruby Mormon Creek Flora and the Upper Oligocene Ruby Passamari Flora (paper shales), recently studied at The New York Botanical Garden, are examples of two contrasting floristic and climatic epochs.

At the concluding informal dinner in the New York Academy of Sciences building, Dr. Allen T. Waterman of The National Science Foundation spoke on the achievements of meteorologists during the post-war years, and also warned of the potential dangers to humanity inherent in the unscrupulous application of scientific information which may well outpace its reasonable management and use by man. "What a calamity to the world it would be if, somehow, the roof of the Academy building would fall in and all the leading proponents in this field of meteorology, here assembled, were no more."

Abstracts of all the papers were printed in time for the conference, and complete papers will be published within six months or as one volume of the *Annals of The New York Academy of Sciences*. This work will supplement an earlier volume as a standard text in meteorology and allied subjects for several years to come.

HERMAN F. BECKER

Spring Garden Tour to historic Bucks County on May 10, 1961, will include the Washington Park Memorial Building, the Thompson Neely House (1702), the Bird Banding Station, and the Wildflower Preserve on Bowman's Hill. In New Hope, Pennsylvania, the group will see Lenteboden Gardens with its beautiful display of more than eleven hundred separate plantings of tulips and other bulbs; the Miller Gardens, noted for its early blooming rhododendrons; the Beaumont House and Gardens built around 1800; the F. T. McClintock Residence and Gardens; and Mechanic Street where the houses date back to 1743.

Lunch will be served at the River's Edge Restaurant on the Delaware River in Lambertville, New Jersey.

This all-day tour is sponsored by The Volunteer Associates of The New York Botanical Garden. The buses will leave at 8:15 A.M. from 22 East 60th Street, New York City. The all-inclusive ticket covers transportation, tour of the houses and gardens, and lunch: price for members of The Garden, $10.50; for non-members $12.50. Send for tickets to The New York Botanical Garden, 22 East 60th Street, New York 22, New York.

Staff Seminars. Dr. Robert F. Thorne, Professor of Botany at the University of Iowa, who had just returned from an extensive study of the native vegetation of Australia, New Zealand, New Guinea, and the Malayan Archipelago, addressed the staff seminar on January 19, 1961. On February 23, 1961, Miss Lorna Maitland of London, England, talked about "Wild Flowers of Down Under." On March 23, 1961, Dr. Steere, Director, will address the staff on "Botanical Activities in Argentina."

Gilbert H. Montague died at his home in New York City on February 4, 1961, at the age of eighty. Mr. Montague had been a member of the Corporation and of the Board of Managers of The New York Botanical Garden since May 1952.

He was one of the country's authorities on antitrust law and was called upon by members of the United States Senate and of the House of Representatives for opinions for the public good. In 1953 Mr. Montague was appointed a member of the Attorney General's Committee to Study Antitrust Law by Herbert Brownell Jr., then the United States Attorney General. Much of the work on the Committee's report was done by Mr. Montague.

He was a collector of rare and valuable manuscripts; among them a fourteenth-century manuscript of the Magna Charta, which he presented to the Law Library of Harvard University; the works of Hugo von Hofmannstahl, which he gave to the Houghton Library; and the works of Emily Dickinson, a collateral relative.

His beautiful estate "Beaulieu" at Seal Harbor, Maine, was visited by many amateur and professional gardeners before it was destroyed by fire in 1956.

Jacques Cattell, editor and publisher of the directory, *American Men of Science,* died on December 25, 1960, at the age of fifty-six in Phoenix, Arizona. His father, the late Dr. James McKeen Cattell, Professor of Psychology at Columbia University, founded *American Men of Science* in 1906.

Mr. Cattell had also been publisher of *American Naturalist* and editor of another directory, *Readers in Education.* He was at one time editor of *Science,* editor of the *Biographical Directory of American Scholars,* and president of Science Press Publishing Co., of Lancaster, Pennsylvania.

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